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ANNALS *of* SURGERY

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HYPOPHYSEAL DUCT TUMORS

A REPORT OF THREE CASES AND A FOURTH CASE OF CYST OF RATHKE'S POUCH

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Introduction.—In view of the very small number of squamous epithelial tumors of the hypophyseal region which have been reported in this country and their many points of interest, it seems permissible to call further attention to this group and to report in some detail a pathological study which has been made of three cases occurring in the surgical service of Professor Halsted of the Johns Hopkins Hospital.

The relative rarity of squamous epithelial tumors among hypophyseal neoplasms is suggested by the small number reported in the American literature. Among twenty-six hypophyseal tumors (certified histologically) reported by Cushing (1912), only two belong in this group. Jackson, in 1916, reported a case and referred only to the two of Cushing and another published by Dean Lewis (1910). To these should be added those of Farnell (1911) and Warthin (1916), as well as the three to be presented in the following paper. Erdheim (1904) observed at time of autopsy only two of these tumors, but pathologically resurrected five others which had been salvaged and preserved in the University of Vienna Museum between the years 1828 and 1883. In addition to these he collected about twenty cases from the literature which he decided belonged in the same group. Jackson (1916) tabulated thirty-eight examples, collected from the literature, to which I may add a full dozen, histologically certified tumors, reports of which I have found.

Classification.—Included among the squamous cell tumors of the hypophysis and infundibulum are tumors which range in structure from simple squamous epithelial-lined cysts to tumors which are often reported as teratomas, but which are probably "autochthonous teratoids developed by metaplasia from hypophyseal duct remnants" (Ewing). Case III of the present series and the case of D'Orsay Hecht (1909) appear to be examples of such "teratoids." Tridermal teratomas are rare, but instances have been reported by Wegelin, Rippmann (1865), and Kon. The entire group of squamous epithelial cell derived tumors belong to the general group of *heterogenous* hypophyseal tumors, the so-called *heterotopic* group

of Bonin, meaning that such tumors are composed of tissue foreign to the essential structure of the adult gland.

Embryology.—Although the embryology of this region is so well and generally known, it may help the reader to review briefly the salient features that have a bearing in the etiology of this special group of tumors.

Although Rathke first asserted in 1838 that the hypophysis developed from a diverticulum of the pharynx, it was not until 1875 that the essential points in its development were settled and clearly presented. At this time Goette and Mihalkovics demonstrated independently the ectodermal origin of the anterior lobe of the hypophysis. Mihalkovics' work, which was done on canine material, has received most attention and his findings confirmed by the work of subsequent observers.

Meantime, in 1860, Luschka had noted the presence of squamous epithelium in the normal hypophysis, but the pathological significance of this finding remained unappreciated for many years. Prior to Luschka squamous epithelial lined cysts had been observed (Zenker in 1857), and subsequently a number of such cases were put on record.

Erdheim (1903) in his studies on the structure of the normal thyroid had been interested in the occurrence of epithelial rests of the thyroglossal duct. Subsequently his observation of numerous squamous epithelial groups in a single "normal" hypophysis stimulated him to undertake a study of *serial sections* of thirteen adult normal hypophyses, in ten of which squamous epithelial cell rests were found (1904). This squamous epithelium occurred as small cell groups (in which intercellular bridges were demonstrable) located usually along the anterior surface of the infundibulum (the *processus lingualis* of the *pars intermedia* of Herring, 1907) or beneath the capsule of the upper surface of the anterior lobe. Turning to Mihalkovics' work, Erdheim found it already demonstrated that the rotation forward and upward of the developing anterior lobe carried the area of attachment of the hypophyseal duct to precisely the location of the *reliquii* (inclusions) of squamous epithelium found in a large majority (about 77 per cent.) of normal hypophyses.

Jackson's (1916) quotation to the effect that Erdheim "on careful examination of thirteen suitable fetuses discovered that ten of them, or over 80 per cent, showed remains of buccal epithelium in the infundibular region," appears to be somewhat in error, since the thirteen hypophyses examined microscopically were those of adults. Erdheim discarded seven foetal and new-born hypophyses because of the difficulty of recognizing squamous epithelial cell groups in the presence of incompletely differentiated hypophyseal parenchyma. This detail of Erdheim's work was correctly quoted by Dean Lewis (1910).

An anatomical point of importance in the consideration of the tumor producing potentialities of this region lies in the fact that the hypophyseal vesicle or sac, a later stage of Rathke's pouch, is composed of stratified cylindrical epithelium. Most of this tissue develops into the anterior lobe, but a single layer of cylindrical epithelium persists in the adult gland as the "*cleft*" ("Rathke's" cleft), separating the anterior and posterior lobes. On the contrary, the hypophyseal duct is composed of modified squamous epithelium which gradually passes over into the cubical epithelium of the buccal canal (Salzer, 1898). Furthermore, while the vesicle progresses, the duct retrogresses entirely, save for its cellular *reliquii*.

The following extract is of Erdheim's summary of Mihalkovics' illus-

HYPOPHYSEAL DUCT TUMORS

trated explanation of the development of the hypophysis and the rôle of the hypophyseal duct.

In Fig. 1, "I," we see the *anlage* of the central nervous system, the fore (*v*), mid (*m*), and hind (*h*) brain vesicles, respectively. Between the ectodermal primary buccal cavity (*n*) and the entodermal foregut (*f*), stretches still the oral plate (pharyngeal membrane or "*rachenhaut*"). High above and at the same time behind, one finds a small depression (*h*) in the oral cavity, the "hypophysis angle" ("ch" in this and subsequent stages = chorda dorsalis). In Fig. 1, "II," the oral plate is ruptured and the pituitary anlage (*h*) deepened to a small cavity. At (*i*) the infundibulum has already begun to deepen. A further step (Fig. 1, "III,") shows that the small cavity has become the deep pituitary pouch ("h" = Rathke's pouch), "which is lined by stratified cylindrical epithelium."

In "IV" the pocket in its upper part has developed into the thick-walled "pituitary sac" (*h*), composed of stratified cylindrical epithelium, while the under part has developed the small pituitary or hypophyseal duct (*g*) with a very narrow lumen (not shown in the figure) lined by low cubical epithelium. The differentiation of the hypophysis anlage into two totally different (in both form and cell structure) parts is an important fact. Whereas the pituitary sac develops into the anterior hypophyseal lobe, the pituitary duct disappears.

Already at this stage (Fig. 1, "IV") one sees that the pituitary sac is slightly curved. The infundibulum (*i*) has grown and lies on the posterior surface of the pituitary vesicle. In a further stage (Fig. 1, "V") one sees that the angular kinking of the pituitary sac ("H") has progressed and that the epithelial wall of the lower part of the sac at the place where it is connected with the canal (*g*) has developed a solid process (*p₁*) anteriorly and above. The lumen of the sac sends forward into the solid process a small cavity. The hypophyseal duct ("g") has lost its lumen and remains as a thin solid strand of epithelium which connects

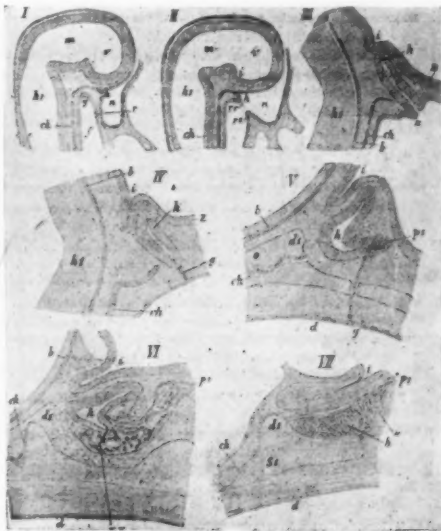


FIG. 1.—Illustrates the developmental cause of the suprasellar and upper sellar location of hypophyseal duct squamous-cell tumors. After the closure of Rathke's pouch (III, *h*) its connection (IV, *g*) with the pharynx is known as the hypophyseal duct. This is lined with modified squamous epithelium continuous with the pharyngeal mucosa. During the further development of the hypophysis the point of insertion of the hypophyseal duct (IV, *g*) is carried forward and upward (VII, *x*) by the rotation of the embryonic anterior lobe. This developmental fact correlates with the frequent occurrence in the mature gland of squamous epithelial inclusions along the infundibulum (in the processus lingualis of the pars intermedia), or near by beneath the capsule of the anterior lobe. The location of these inclusions corresponds with that of many squamous epithelial derived tumors. (After Mihalkovics.)

the solid process of the primitive anterior lobe ("p₁") with the pharynx and runs between both sphenoidal bone cartilages (Fig. 1, "V").

In the further development of the glandular part of the hypophysis the solid process plays the cardinal rôle. In Fig. 1, "VI," one sees the *process* (p₁) already changed into a large number of solid glandular columns and that the lumen ("h") has come to lie somewhat eccentrically behind. Both sphenoid cartilages are united and the pituitary duct is no longer seen. The infundibulum (i) is still canalized. In the most mature stage (Fig. 1, "VII"), illustrated by Mihalkovics, one sees that the posterior part of the infundibulum ("i") has become the posterior lobe and now lies upon the anterior lobe ("h"). The lumen of the hypophyseal vesicle (about to become the "cleft" between the two lobes) is still present and still sends a small diverticulum into the glandular tissue. The glandular process (p₁) has been pushed forward and upward and lies below and along the anterior surface of the infundibulum. *The region of insertion of the erstwhile hypophyseal duct (Fig. 1, "VII, X") is carried upward, by the further rotation of the developing gland, to the anterior infundibular and upper pars anterior surfaces.*

It is in this locality that squamous epithelial cell groups have been commonly found and where the group of squamous epithelial neoplasms under consideration appear to have taken origin: either from the anterior surface of the infundibulum (Cushing, page 289), or from beneath the capsule of the anterior lobe (*cf.* Case I of the writer, in which the pars anterior was flattened cup-like below by a squamous epithelial cyst situated partly within and partly above the sella).

The Accessory Hypophyses.—A number of interesting researches have been concerned with the questions of patency of the craniopharyngeal canal and the finding of rests of the hypophyseal duct. Among the lower vertebrates it is well known (Jordan, D. S., 1896) that in *cyclostomata* the external pituitary opening remains patent throughout life. In *myxine* the pituitary opening extends into the pharynx and serves as a respiratory tube.

In human crania Le Double in 1903 (cited by Arai, 1907) found the canal patent in 9 per cent. of newly born (aged one to three months). Arai found with considerable regularity on histological examination of canine and feline crania three different bodies situated between the sella and the pharynx which, in addition to squamous epithelium, often contained elements similar to those of the anterior hypophyseal lobe. He designated these "*accessory hypophyses*" as: (1) *Hypophysis accessoria cranii* (later, 1911, independently found by Dandy in canine crania and called the "*parahypophysis*"); (2) *hypophysis accessoria canalis craniopharyngei*, found in the body of the sphenoid bone; and (3) *hypophysis accessoria pharyngei*, the so-called pharyngeal hypophysis or *rachendachhypophyse* of other writers. Habersfeld (1909) found the pharyngeal hypophysis present in all of fifty-one pharynges examined, of all ages from infancy to senility.

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It was larger in adults than infants, and often differentiated into tissue resembling anterior hypophyseal lobe. Haberfeld concluded that its function must be similar to that of the chief hypophysis. As an example of tumor formation in one of these accessory hypophyses may be mentioned the acidophile adenomatous tumor of Erdheim (1909) which in a case of acromegaly was found within the body of the sphenoid.

E. Christeller (1914), investigating the pharyngeal hypophysis in the human, made serial sections in thirty-one cases, and found the organ present in every case. In three cases in which functional disturbance of the chief hypophysis was diagnosed clinically he looked for possible histological changes in the pharyngeal organ. In one case of typical acromegaly associated with an acidophile adenoma of the chief hypophysis, the pharyngeal hypophysis existed only as groups of squamous epithelium. In the second case, one of *dystrophia adiposo-genitalis* associated with a basophile adenoma, only squamous epithelium was present in the pharyngeal accessory gland, but in the third case, similar to the case just cited, the "*rachendachhypophyse*" was substantially enlarged and composed largely of cells resembling eosinophile anterior lobe hypophyseal elements.

It seems evident that the entire region of the hypophysis from the pharynx to the *processus lingualis* of the *pars intermedia* is peculiarly rich in vestigial reliquii which may be considered as possessing both functional and tumor-producing possibilities. A study of four examples of cystic tumors arising in the region of the upper extremity of this chain of embryonic reliquii will be presented in the following paper.

CASE I.—*Intracystic squamous epithelial papilloma arising from a rest of the hypophyseal duct in the anterior lobe. Enlargement of sella and inclusion of hypophysis in wall of cyst. Headaches and visual disturbances (temporal hemianopsia and amaurosis). Treated for syphilis (positive Wassermann). Operation: evacuation of cyst (lateral intracranial approach); injury to internal carotid, ligation in neck. Exitus twelve days after operation. Autopsy.*

Abstract of J. H. H. Surgical History No. 38232. A white man, thirty-five years old, was transferred October 30, 1915, from the medical to the surgical service of Johns Hopkins Hospital with the persistent complaint of "blindness and headache." The family history was negative, and aside from typhoid fever at nineteen years of age, measles, mumps, and pertussis as a child, the only fact of importance in his past history was the occurrence of a Neisserian infection several years before. However, he denied all primary and secondary luetic stigmata. Beginning in July, 1914, he suffered with left frontal headaches, not severe enough to interfere with his work. Later the headaches became bi-parietal and more recently general in distribution, and usually started about 10 A.M. each day and ceased toward bedtime.

In November, 1914, visual disturbances began. He noticed distant vision was not as good in the left as in the right eye. The left

eye gradually failed. In the spring of 1915 Wassermann tests on the serum and spinal fluid were made at another clinic, and while there he received several injections of salvarsan. Several inunction treatments were given. This therapy is associated by the patient with a progression of visual disability. The right eye began to suffer about two months before admission (August, 1915) and rapidly failed, so that he can barely see to get about. There is only light perception in the left eye. He is practically totally blind.

He has lost forty pounds in the last year, now weighing 152 as compared with 192 a year ago. Thus at the onset of his illness he was fat and is said to have been a red-faced, healthy looking man. There has been no change in the skeletal structures. According to his statement his libido sexualis was perhaps a little below normal before the present illness. Since the latter there has been no *libido sexualis*.

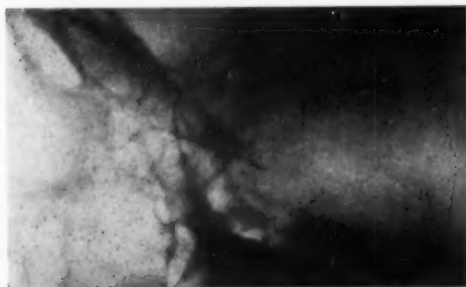


FIG. 2.—Case I. X-ray of base of skull showing destruction of clinoids, enlargement of sella and slight encroachment upon sphenoid space. This tumor, as subsequent pictures will indicate, originated in the upper surface of the anterior lobe below the dural diaphragma sellæ. Hence the enlargement of the sella in contrast to the two other cases in which the origin was suprasellar (cf. Figs. 10 and 13).

No nausea or vomiting.

Examination.—A well-developed man, rather pale.

Eyes: wide pupils, sluggish pupillary reaction to light on right; no reaction on left.

Fundi: showed marked pallor of temporal margins with swelling of nasal margins and fullness of vessels. Changes more in left fundus.

Visual acuity: left *nil*; right 6/200.

Course in hospital:

While on the medical service a positive Wassermann test was present in the spinal fluid together with a luetic zone reaction in the colloidal gold test. He received salvarsanized serum intraspinously on two occasions.

X-ray report: October 15th (Dr. F. H. Baetjer). "Sella flattened out with destruction of posterior clinoids suggesting tumor" (Fig. 1).

Visual fields: Temporal hemianopsia on right, no vision in left eye.

Carbohydrate tolerance tests: No sugar in two specimens six and twenty-four hours after taking 100 grams of glucose.

Urine showed slight albumin with occasional granular casts, but repeated examinations were negative.

Operation.—October 30, 1915. Dr. G. J. Heuer. *Evacuation of hypophyseal cyst.* Usual lateral (left) approach as developed by the operator.

Findings: Unusually large collections of fluid in subarachnoid space, possibly related to recent salvarsanized serum injections.

The left optic nerve was stretched and dislocated outward. The tumor bulged forward between the two nerves. It was bluish and

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apparently cystic. On puncture with a needle probably an ounce of brownish fluid escaped.

On attempting dissection of the cyst wall a hemorrhage occurred which could be controlled only by pressure and with the greatest difficulty. The left internal carotid artery evidently was seriously injured. This vessel was ligated in the neck just above the bifurcation of the common carotid. The cranial wound was then closed after placing rubber tissue drains down to the dura through the decompression opening.

Post-operative Course.—The patient apparently did very well until twelve days after operation, when there was sudden collapse, respirations ceasing. He was kept alive by artificial respiration for several hours, during which time there occurred a series of convulsions involving the left side particularly. Exitus.

The autopsy was made by Dr. A. B. Dayton, to whom I am indebted for the pathological material and use of the protocol.

Autopsy (No. 4508. November 12, 1915.—*Anatomical Diagnosis.*—"Squamous epithelial papillomatous cyst developing from a rest of Rathke's pouch." Operations: (1) lateral craniotomy and evacuation of cyst in hypophyseal region, (2) ligation of left internal carotid artery.

Bronchopneumonia. Pulmonary infarcts. Chronic appendicitis. Phleboliths of spleen and liver.

Body.—Is that of a white man 176 cm. (5 ft. 10 in.) in length. The skin is of smooth texture and the pubic hair is rather scanty, but has the normal masculine arrangement. It is also scanty on the face and in the axillæ. The pupils are regular, the left measuring 4 mm. and the right 5 mm. The scleræ are clear. The nose and ears present nothing of note. The teeth are in good condition. The genitalia are apparently normal. Just below the left angle of the jaw there is a horizontal scar of a recent operation about 4 cm. in length. On the scalp there is the wound of the usual temporal flap operation, which exposes the left frontal and temporal lobes. This, likewise, has healed *per primam*. There is very little, if any, bulging.

Though the patient is not very obese, there is considerable subcutaneous and retroperitoneal fat. There is no excess of peritoneal fluid and the surfaces are everywhere smooth and glistening. The appendix is about 9 cm. in length. Its serous surface is greatly injected, looks swollen and œdematous, is club-shaped, and at its extremity it has a diameter of about 1 cm. There is one delicate, fibrous adhesion. The other abdominal viscera seem normally disposed. The mesenteric lymph glands are not enlarged.

The left pleural cavity is free of fluid and its surfaces are everywhere smooth and glistening. The right pleural cavity is free of fluid. There are a few delicate fibrinous tags binding the edge of the lower lobe down to the diaphragm. There is considerable fat in the anterior mediastinum, and in picking this to pieces it is thought that there is some thymus tissue present. Roughly estimated, the latter amounts to 15-20 grams. The pericardial sac contains 10 c.c. of lemon-yellow fluid. Its surfaces are everywhere smooth and glistening.

Thyroid: Weight 31 grams, soft in consistency and of normal appearance. Parathyroids: Two were dissected out, of normal size and appearance. Adrenals: Together weigh 10 grams. Normal. Testicles: Are of normal size, consistency and gross appearance on section. Heart: Weighs 350 grams,

otherwise normal. Spleen: Weighs 150 grams. Acute splenic tumor. Subcapsular phleboliths. Pancreas: Weighs 110 grams. Normal. Liver: Weighs 1900 grams. Phleboliths similar to those of the spleen.

The left internal carotid after dissection showed a double silk ligature just above its point of origin from the common carotid. An antemortem thrombus was present.

Gall-bladder, neck organs and aorta normal.

Examination of Tumor, Brain, and Skull by the Writer.—After the routine injection of the brain *in situ* with 10 per cent. formalin it was removed with the tumor intact. This left the sella (Fig. 4) practically bare. The latter

measured 3 x 3 cm. in its antero-posterior and transverse diameters, and was about 1.5 cm. in depth. There was no defect in its floor, which seemed thinned, but the lateral and posterior walls were greatly affected. Both posterior clinoids were destroyed and the residuum of the dorsum sellæ was only about 1 mm. thick. The left postero-lateral wall showed a gross defect (A) corresponding with the prominent pole of the tumor (Fig. 3, A) of the same side. The relative uninvolved of the left anterior clinoid process probably explains why no destruction of the anterior clinoids was apparent in the lateral röntgenogram view of the sella made before operation. The base of the sella showed no defect.

The brain showed only slight flattening of the convolutions over the convexity, but a fairly well-marked compression ring at the base of the cerebellum gave evidence of a moderate degree of herniation through the foramen magnum.

At the time of the autopsy the left hemisphere was quite soft, the ligation of the internal carotid evidently having interfered considerably with its injection with formalin.

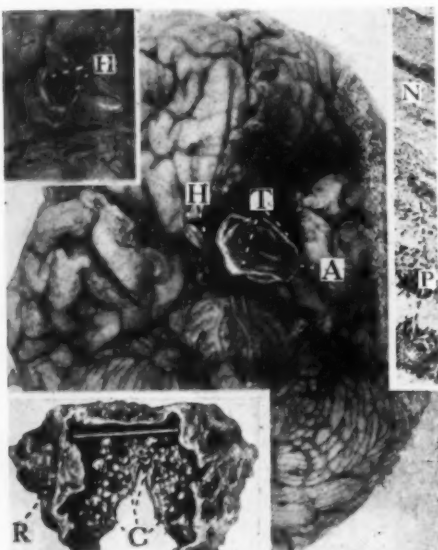


FIG. 3.—Case I. Photograph (reduced) showing tumor (T) at base of brain (removed after fixation *in situ* by injection of 10 per cent. formalin). The left lower insert is a retouched print to show the cauliflower-like intracystic papillomatous mass (C) on the superior inner surface of the cyst. The lower half of the cyst wall shows a mass (R) consisting largely of anterior lobe hypophyseal elements (cf. Figs. 6 and 7). The accessory mass (H), enlarged after incision in left upper insert, proved to be a hemorrhage in the left optic nerve. The upper right insert is a low-power photomicrograph of a segment of the nerve bordering the hemorrhage. P = large phagocytes laden with blood-derived pigment. N = perivascular round-cell infiltration.

The corresponding cerebral vessels on the left, the anterior cerebral, likewise the main cortical vessels and the superior sagittal sinus, were full of postmortem blood clot. The right internal carotid was normal. Both posterior communicating arteries seemed abnormally large, measuring about 1.5 mm. in diameter. The left was considerably stretched by the tumor. The left internal carotid for a short distance was surrounded by tumor and contained a dense clot, which seemed in the gross to be of antemortem character. The optic chiasm was dislocated far to the left and somewhat backward. The right optic nerve appeared rather slender and showed "a small cystic tumor mass" (Fig. 3, H) .8 x .7 cm. in diameter at a point about 1.5 cm. from where the nerve left the chiasm this mass seemed to be in the sheath of the nerve. There was no subsequent note concerning this local metastasis

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(?) in the protocol. Examination by the writer finds a circumscribed brown to yellow-colored *hemorrhage* in the location of the above-described "tumor mass" (Fig. 3, *H*). The entire small mass in the right optic nerve is excised for microscopic confirmation.

Coronal section of the brain showed some diffuse hemorrhage in the left parietal lobe. Possibly most of this was caused at operation in exposing the hypophyseal region, but ligation of the internal carotid with possible subsequent softening may be a factor in the changes here.

The cranial nerves are normal save for the above referred to optic nerves and slight traumatism to the left olfactory nerve.

The tumor (Fig. 3) was an irregular spherical cystic mass, which measured $3 \times 3 \times 2.5$ cm. in diameter, situated in the hypophyseal region. The hypophysis as a separate organ could not be located. After removal of the brain with cyst attached, the sella (Fig. 4) was left quite bare. Any residuum of the hypophysis must obviously be incorporated in the tumor. Neither was any trace of the infundibulum found at the time of the autopsy. Exami-

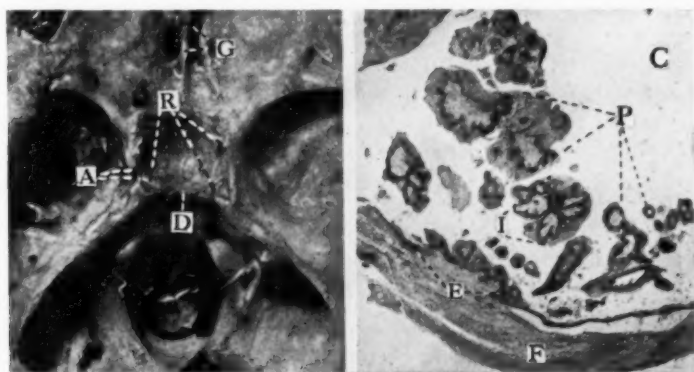


FIG. 4.—Case I. Photograph (reduced) at left of base of skull showing dilated sella. Clinoids (*R*) largely destroyed. Dorsum sellae (*D*) thinned. Postero-lateral wall shows an erosion (*A*) corresponding with the prominent pole of the tumor (Fig. 3, *A*). *G*=crista galli. The picture at the right is a low-power photomicrograph of an upper angle of the collapsed cyst showing the strikingly papillomatous intracystic growth (*P*) composed of squamous epithelium. Lining the fibrous wall (*F*) is a layer of similar epithelium which shows sessile papillomatous masses in places (*E*). The papillomatous mass (*I*) is shown further enlarged in Fig. 5. *C*=cyst cavity.

nation at the present time of the base of the brain discloses no evidence of the infundibulum in the region of the tuber cinereum. Instead this locality appears to have been in close relation with the wall of the tumor mass. The floor of the third ventricle is intact, the ventricle not dilated. The choroid plexus of this and the other ventricles is normal in appearance. The pineal is normal in gross appearance. The region of the tuber cinereum shows some yellow-brown discoloration, apparently hemorrhagic in character.

The tumor then had replaced the infundibulum and largely obliterated the hypophysis, filled the sella and extended above, closely involving the surrounding structures and being in close relation with the floor of the third ventricle.

At the time of removal of the brain the cyst ruptured and "a degenerated portion of the tumor" measuring $2 \times 1 \times 1$ cm. was extruded. It seems probable that this was part of the papillomatous intracystic mass, although it may possibly have been coagulated serum.

Fig. 3 (lower insert) shows the cyst after detachment from the brain. It has been incised and spread open. The wall is seen to vary greatly in

thickness, and it seems likely, in view of the microscopic findings, that this is due largely to the presence of hypophyseal tissue in the basal portion (Fig. 3, *R*) of the tumor wall. On the interior of the wall may be seen numerous small raised papillomatous masses (Fig. 3, *C*), having a somewhat cauliflower appearance, but the greater part of the cyst contents are lost.

Microscopic Examination.—The Tumor: The cyst wall (Fig. 4, *F*) varies in thickness from 1 to 6 mm. It is composed largely of fibrous tissue, with considerable hyalinization. Lining the interior of the cyst is a zone of stratified squamous epithelium (Fig. 4, *E*) with typical intercellular bridges, but no horny layer. In the cyst cavity lie cross sections of papilloma masses (Fig. 4, *P*) covered with similar epithelium. Of the latter, the more deeply staining layer of basal cells (Fig. 5, *B*) is sharply differentiated from the connective-tissue framework of the villous-like processes. This central framework (Fig. 5, *C*) is composed of a fairly loose connective tissue, which carries the nutrient blood-vessels (Fig. 5, *S*). Where the papillary contents of the cyst have not been lost they loosely fill the cavity (Fig. 4, *C*) of the cyst. The papillary masses are mostly of a pedunculated character, relatively

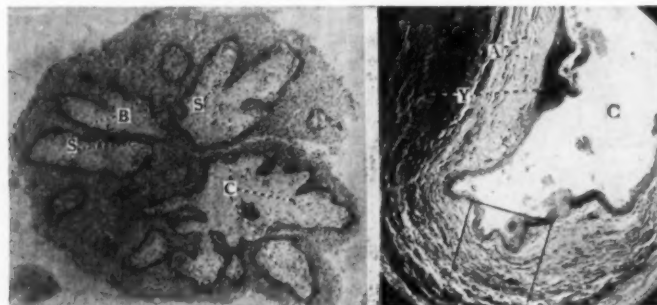


FIG. 5.—Case I. The photomicrograph at the left is a further enlargement of one of the papillomatous processes (Fig. 4, *P*). The squamous epithelial character of it is distinctly shown. *B*=basal layer of epithelium. *S*=blood-vessels which lie in a fibrous stroma (*C*). At the right is a very low-power photomicrograph of a segment of the cyst wall from which the papillary ingrowth is largely lost. *C*=cyst cavity. *Y*=areas of hemorrhage. The squared area is further enlarged in Fig. 6.

few processes of sessile appearance being found (Fig. 4, *S*). The stalks of the pedunculated processes are rarely to be seen anywhere, so that the absence or presence of these in other parts of the cyst where the contents have disappeared cannot be used as a criterion in determining whether the intracystic papilloma arose equally from all parts of the lining or only in the region where they are still to be seen. It seems probable that the cyst was equally filled throughout with growth similar to that shown in the photographs, and that the mass extruded at autopsy and subsequently lost probably consisted largely of these papillary masses. In the latter the basal layer of cells is everywhere intact. No invasion of the underlying stroma or other malignant criteria are present. The squamous epithelial lining of the cyst in these large sections occasionally sends short processes into the wall, but nowhere do these have a malignant appearance.

The wall of the cyst is well preserved in several microscopic sections. Two blocks for study were taken through nearly the whole circumference of the cyst near the mid-line, and a third, of similar extent but away from the mid-line, consequently of much smaller dimensions. The fibrous tissue of the wall is mostly of a dense type. Extensive areas of hyalinization are present, some of which possess a marked lamellated appearance. This,

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together with the sinuous outline of the tissue, causes in certain areas a resemblance to an arteriosclerotic *aortic* wall. Numerous areas of hemorrhage (Fig. 5, *Y*; Fig. 6, *H*) are present throughout the wall. Some of these are large and show no attempt at organization. Other smaller ones show fibroblasts extending throughout the clot, while a rich granulation tissue may encompass the periphery of such areas.

Anterior lobe hypophyseal tissue is present in the wall of the cyst (Fig. 6, *A*). In one section strands of anterior-lobe epithelium extend for a distance of about 3.5 cm. Much of this consists of only a few strands of cells in thickness, but over an extent of about 1 cm. there is a thickness of about 12 to 15 strands or cords of anterior-lobe cells, and for a similar extent tissue of about half this thickness is present. These cells are well preserved (Fig. 7, *A*), showing perfectly differentiated eosinophile, basophile and chromophobe cells (the last few in number). In a certain area a recent hemorrhage has widely separated the strands of anterior-lobe tissue, and here the cytoplasm of such cells tends to stain less strongly, although the nuclei still take the stain well and the great majority of cells are apparently still viable. The granules of the eosinophiles are sharply stained (haematoxylin and eosin stained celloidin and paraffin preparations). In addition to strands of cells there are fairly large areas, 1 mm. or more in diameter, in which the flattening of the cell groups is not so marked, and they are arranged in characteristic acini. The intimate blood supply of the strands, columns, and acini of anterior-lobe elements is quite well preserved

in spite of the fact that such tissue often lies in a fairly dense fibrous wall. Capillaries in most instances lie adjacent to strands or tubules, and in some cases the anterior-lobe cells delicately line these endothelial spaces. Most of the acinar areas are composed of well-stained cells, but areas are found where such is not the case. One of the latter areas is somewhat detached from the external surface of the cyst wall, and its cells are beginning to undergo necrosis. There is considerable hemorrhage in this area, and the base of it shows a mass of granulation tissue growing into it from the wall of the cyst. None of the cells of this degenerating mass appear to be of the eosinophilic type.

In the large microscopic preparation, which comprises practically the whole median circumference of the cyst wall, is found a large area of necrosis (cf. Fig. 3, *R*), about 3 x 4 mm. in diameter. This is composed of

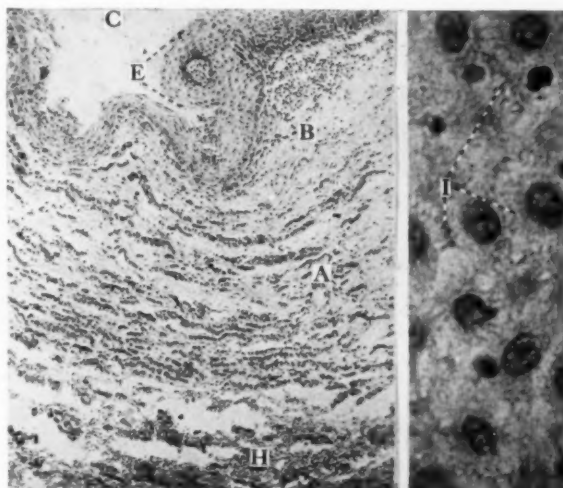


FIG. 6.—Case I. At the left is shown a medium-power enlargement of the squared area in Fig. 5. Strands of anterior lobe hypophyseal cells (*A*) lie in the fibrous wall. *E* sessile projection from squamous epithelial lining of cyst. *B*=basal layer. *C*=cyst cavity. *H*=zone of hemorrhage. At the right is a photomicrograph (oil immersion magnification) showing the presence of intracellular bridges (*I*) in the squamous epithelium of the tumor.

anterior-lobe elements, most of which show a definite acinar arrangement. It occupies almost the whole thickness of the cyst wall at this point, and throughout most of its circumference is surrounded by a vascular granulation tissue. In the latter zone are found isolated anterior-lobe elements, as well as entire acini lined by cells or filled with detached cells, which are in various stages of degeneration (Fig. 7, *N*, *R*). Many of these cells show the characteristic granulation of eosinophilic anterior-lobe elements. Indeed such granulation is seen in some cells in the necrotic mass whose nuclei do not take the stain.

Throughout the latter area, but more especially at the periphery, one sees numbers of colloid-like accumulations, some of which are quite homogeneous and refractile, others of which still show a fine granulation. Some of these are several times the size of a large eosinophilic anterior-lobe cell. A few of these hyaline accumulations lie in the meshes of the wall adjacent to the cyst cavity, which at this place has lost (desquamation or trauma?) its epithelial lining. The smaller of these masses resemble the *hyaline*

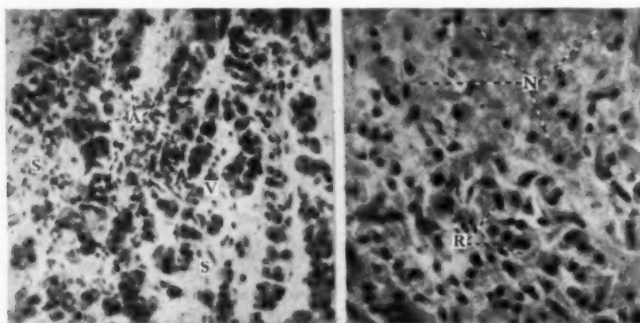


FIG. 7.—Case I. At the left is a photomicrograph showing an area in the wall of the cyst where clumps of anterior lobe hypophyseal elements (*A*) are thickly scattered through the stroma (*S*) of the cyst wall. The photomicrograph at the right is of a section taken through the area *R* of Fig. 3, where a large amount of anterior lobe tissue was present with very little stroma. Much of the area had undergone necrosis and the photomicrograph is taken through the edge of the necrotic tissue. At *N* are necrotic cells, while at *R* are cells the cytoplasm of which stains faintly but the nuclei take the stain well.

bodies of the pars nervosa described by Herring. (Concerning the latter, it is not clear whether they are the secretion product of epithelial cells of the *pars intermedia*, which may have penetrated the pars nervosa, or whether they may result from the degeneration of single epithelial cells. The occurrence of numbers of similar bodies in close relation to a mass of anterior-lobe tissue undergoing extensive necrosis would seem to favor the view that such material may possibly result from a degeneration of cells in bulk, rather than an accumulated secretion of one or more cells. However, the analogy is not complete, since the hyaline bodies of Herring arise presumably from the intermedia epithelium, whereas the tissue here described is apparently solely anterior lobe.) As to the causation of this necrosis, it would seem most likely due to interference with the blood supply, possibly owing to the operative procedures. It is evidently a comparatively recent affair.

There is evidence also of the presence of *pars intermedia* elements in the wall of the cyst. This consists of a number of epithelial glands lined by cubical or columnar epithelium, and either flattened out, appearing as tubules, or else larger and ovoid in outline. In the latter case they may contain material of a colloid-like appearance, taking the pink stain well. Usually

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they have been flattened out by the pressure of the cyst, and their long axes lie parallel with the circumference of the cyst wall. There is no apparent evidence of these glands discharging any secretion into the cyst cavity.

No posterior-lobe tissue could be identified, although there was almost similar appearing connective tissue in places.

Polymorphonuclear leucocytes are scattered through the cyst wall, and in fewer numbers occur throughout the structure of the papillomatous processes, both through the stroma and in the epithelial covering.

Numbers of foreign body giant cells lie in the wall of the cyst, usually associated with the absorption of blood pigment, but in places found at the periphery of clear spaces (Fig. 5, *A*), from which cholesterol crystals have been dissolved out by the process of fixation of the tissue.

Section through the *mass* (Fig. 3, *H*) in the *right optic nerve* shows a large (1 cm.) recent hæmatoma. This has expanded the nerve to a thin shell. In the wall one sees great numbers of large mononuclear phagocytes (Fig. 3, *P*), similar to the "compound granular cells," loaded with black hæmatogenous pigment. Occasional small hemorrhages and œdematous areas have further disturbed the remaining nerve substance. A striking feature is the presence of focal areas (Fig. 3, *N*) of small mononuclears. These areas are usually perivascular in arrangement and are largest in the sheath of the nerve, extending thence inward along the vascular spaces. It is barely possible that these may be unrelated to the hæmatoma, and of a more chronic significance, related to the syphilitic infection (*vide infra*). The blood-cells composing the hemorrhage are well preserved and show no organization. The bright yellow color which was seen in the gross has persisted and appears as a light yellow to brown, finely granular pigment, comparable to bile pigment under similar (fixation and staining) conditions.

Section through the base of the brain and the aqueduct of Sylvius shows two small ($\frac{1}{4}$ to $\frac{1}{2}$ mm.) isolated hemorrhages. Compound granular cells are very numerous. The aqueduct is patent.

The *pineal* shows no microscopic abnormality.

Thyroid.—Acini normal or perhaps below normal in size. Colloid fills practically all of the vesicles, a few of which are distended, with flattened epithelial lining. A small amount of fetal tissue is present here and there between the acini, but no typical adenoma formation is present; no encapsulation of these small areas. The epithelial lining throughout is of low cuboidal, nearly flat, or more rarely low columnar type. The latter, however, is of such small amount in comparison with the flat type as to be practically within normal limits. The gland appears as a whole to be of normal structure.

Parathyroid.—About 2.5 x 1.5 mm. in size, lying near the above described thyroid section in the loose extracapsular fibrous tissue. Essentially of normal appearance; composed of closely packed columns of cells, with here and there a definite acinar arrangement, occasionally with a small lumen. A small bit of colloid-appearing substance was present in one acinus. The cells show what seems to be a neutrophilic staining affinity, with here and there a slight pink variation.

Testicle.—Despite the recorded (protocol) gross normality, the microscopic examination finds a serious alteration of the normal structure (Fig. 8). Spermatogenesis has practically ceased. The seminiferous tubules, for the most part, are lined by one (Fig. 8, *S*) or two layers of cells, which, in striking contrast to the normal, exhibit no mitotic figures. None of the cells have advanced beyond the stage of secondary spermatocyte. No spermatozoa or spermatids are found. The tunica propria (Fig. 8, *T*) is hyalinized and con-

siderably thickened. A few tubules are seen, in which the epithelial cells have lost all resemblance to spermatocytes and look like fibroblasts. The *tunica propria* of such tubules show a marked fibrous increase.

The interstitial tissue (Fig. 8, *M*) shows a moderate increase in connective tissue, both diffusely and in strands and patches, the latter of which are 1 mm. or more in diameter. Much of this connective tissue shows well-formed fibrils and elongated flattened nuclei, evidently a connective tissue of not very recent formation. However, most of it is rather loosely meshed, apparently due to œdema. Occasional small areas of round-cell infiltration were found. No miliary gummata were found.

Dr. R. B. Mills, who has recently (1919) made a special study of the testicle, was kind enough to examine sections from this testicle. In his opinion, the cessation of spermatogenesis is complete; practically only Sertoli (supporting) cells remain in the tubules. The interstitial cells of Leydig he found to be present in normal numbers. As to the causation of the changes he gave no opinion.

Thymus.—Isolated, irregular branching clumps and strands of lymphoid

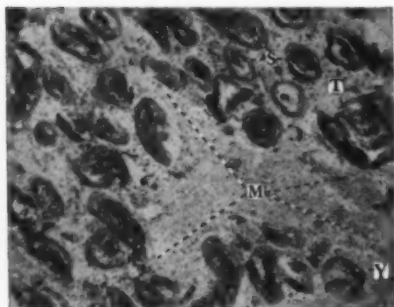


FIG. 8.—Case I. Photomicrograph (low magnification) of the testicle. Spermatogenesis has ceased. The single layer of cells (*S*) present in most of the tubules is composed of Sertoli cells. The basement membrane (*T*) is thickened and occasional tubules devoid of epithelium (*V*) are found. At *M* is a patch of loose fibrous tissue. A slight increase in stroma is present elsewhere.

tissue lie scattered through a fatty framework. The Hassell's corpuscles show no proliferative changes, but, on the contrary, a number of them are hyalinized with non-staining nuclei. Some of these corpuscles apparently are being phagocytosed by large foreign-body giant-cells. The capsule of the gland is 1 mm. thick and composed of hyalinized fibrous tissue. Fairly large vessels lie here and there throughout the fatty meshwork, but the vascularization of the lymphoid areas is not striking. Regressive changes in the gland seem predominant.

Pancreas.—The islands are numerous and showed no hyalinization.

Elsewhere no fibrosis was made out. A special study was not made of the gland, but in the hæmatoxylin and eosin stained preparations nothing abnormal was found.

Appendix.—Shows a marked grade of chronic appendicitis. In places the wall is 4 mm. thick. The mucosa is lost in some places, whereas in others fibrous changes have occurred. The thick fibrous wall is infiltrated with small mononuclears and eosinophilic polymorphonuclears.

Adrenals.—Show no striking changes.

Liver and Spleen.—Normal save for a few uncalcified phleboliths.

Lung.—Purulent bronchitis, section from upper lobe; also a small fibrous-encapsulated calcified area.

The lower lobe—the sections show an infarct, small areas of broncho-pneumonia, and large areas of hemorrhagic broncho-pneumonia.

Summary of Case I.—A previously healthy white man, thirty-five years old, began rather abruptly to suffer with severe headaches, progressive diminution of vision, and loss of libido sexualis. In different clinics, although he denied luetic infection, positive Wassermann tests

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resulted in anti-luetic therapy. Later the diagnosis of tumor in the hypophyseal region was made by means of radiography. The visual fields showed a bitemporal hemianopsia. The exploratory craniotomy was complicated by unusual hemorrhage; however, the cyst presenting above the sella and between the optic nerves was evacuated, and the patient recovered from the immediate effects of the operation, but died twelve days later with symptoms indicating failure of the medullary centres (about one and one-half years after the onset of symptoms).

At the autopsy of this slightly obese man a squamous epithelial intracystic papilloma was found presenting above the enlarged sella with remains of the anterior hypophyseal lobe and traces of pars intermedia preserved in the basal sector of the cyst wall. Death apparently was caused by increased intracranial pressure (cerebral oedema). Testes showed histologically a marked atrophy. Thymus was retrogressive. Other glands of internal secretion showed no definite changes. Changes of subsidiary interest were found in the lung (broncho-pneumonia, pulmonary infarcts) and appendix. *Diagnosis: benign squamous epithelial intracystic papilloma arising from a rest of the hypophyseal duct in the upper surface of the anterior lobe.*

CASE II.—*Cystic suprasellar tumor with adamantinoma characters developing from an infundibular squamous epithelial rest of the hypophyseal duct in a child aged eleven years. Headaches for five years. Excrescence of sex features since age of nine, no marked adiposity. Progressive failure of vision for one year. Projectile vomiting for eight months. Other general pressure symptoms. Operation: Evacuation of cyst and partial removal of cyst wall (lateral operation). Death.*

Abstract of J. H. H. Surgical History No. 42460. A small white girl, eleven years old, was admitted April 20, 1917, to the Surgical Service of the Johns Hopkins Hospital, complaining of "headaches," impairment of vision, and difficulty in walking. For at least five or six years, according to the parents, the child has complained of headaches, general in character, but perhaps worse in front than behind. These have gradually increased in frequency until the past three or four weeks, since when they have been almost constant. Within twelve months the vision of both eyes has gradually but progressively failed. This has become so marked that she cannot recognize faces or objects at table. There has been occasional abrupt and forcible vomiting for eight months. During the last six weeks there has been considerable weakness, finally so much that she cannot stand. Gradual impairment of hearing in last year, during which time she has complained of noises in the head. The child was born after a normal labor. The mother is somewhat robust and masculine looking.

Developmental Phenomena.—Following tonsillectomy two years ago for chronic tonsillitis, with "some arthritis," there occurred marked somatic changes. She increased very rapidly in weight. The hair of the head grew much longer and richer. A moderate growth of pubic hair has appeared (see Fig. 9), but the menses are



FIG. 9.—Case II. Age eleven years. Growth of pubic hair. Apparent beginning development of breasts. No obesity.

still absent. No distinct increased appetite for sweets, but there is a definite history of polyuria (recent incontinence).

The child was brought in chiefly because of increase in headaches and stupor and visual impairment. Slight increase in size of head.

Examination.—A docile, quiet, rather torpid child. Rich, dark curly hair, well-developed mammary tissue with slight pigmentation of the nipples. The bony pelvis has begun to assume some of the proportions of maturity. Bowing of the femoræ is present.

Hirsuties: Well-developed pubic and axillary hair.

Fingers long and tapering, nails curve and are well kept. No prognathism; teeth normal with no abnormal spacing.

Skin: Somewhat dry and harsh.

General physical aside from above facts is negative.

Visual fields could not be taken.

Grip equal on the two sides. Bilateral optic atrophy with choked disk and proliferative changes. Clonus of legs and equivocal Oppenheim and Gordon signs.

X-ray Report (Dr. F. H. Baetjer).—Marked separation of the sutures, partial destruction of posterior clinoids with calcification just above it, suggesting a suprasellar tumor (Fig 10).

Operation (April 24, 1917, Dr. G. J. Heuer).—Evacuation of hypophyseal cyst with extirpation of lining of cyst. Lateral approach.

Findings.—The cyst appeared over the chiasm which was pushed forward. On puncture of the cyst 30 c.c. of thick, peculiar, reddish-brown fluid was obtained. On microscopic examination it showed numerous red blood-cells, a few cholesterol crystals, and some curious rosette-like clusters of small cells, squamous epithelial, apparently. After aspirating this fluid the lining membrane in which were numerous small calcified patches could be stripped away.

NOTE.—Preliminary ven-



FIG. 10.—Case II. Unretouched print from lateral X-ray plate showing suprasellar calcified mass at A. S=separation of fronto-parietal sutures. C=frontal convolutional atrophy. The latter changes make an internal hydrocephalus probable, due most likely to blocking of the ventricular foramina or the iter by the upward growth of the tumor. The heavy calcified mass above A is too far forward to be pineal.

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tricular puncture has shown a high grade of internal hydrocephalus; 120 c.c. of fluid which spurted for a height of six or eight inches.

Died on evening of same day apparently of cerebral oedema. Temperature rose to 105°. Autopsy not obtained.

Microscopic Examination.—The tissue removed at operation (part of the lining membrane of the cyst) consisted of a few small bits of tissue too small to photograph. The tissue was hardened in formalin and embedded in celloidin in three separate blocks.

Examination of sections (Fig. 11) from one block shows a predominance of squamous epithelium, present in masses or processes, or strands which line cystic areas, or constitute the periphery of areas of myxomatous connective tissue (Fig. 11, *M*).

The individual larger mass (Fig. 11, *Y*) is made up of stratified epithelium with peripheral convoluted processes which are covered by a sharply staining basal layer of columnar epithelium (Fig. 11, *E*). The nuclei of the latter are oval or slightly flattened, and occupy the greater part of the cell length save for approximately the distal one-third, which is of clear pale pink cytoplasm. The distal periphery of these cells is capped in certain areas by a thin layer of "membrana propria" (Fig. 11, *P*), which shows an occasional dark flat (shrunken) nucleus. The insert (*X*) at the left shows an unusual basal cell epithelioma-like differentiation present in another block of tissue of the same tumor. *K*=columns of deeply blue staining epithelial cells which lie next to dead masses (*G*) of keratinized epithelium. This basal cell picture was found in one small area in tissue from this case only.

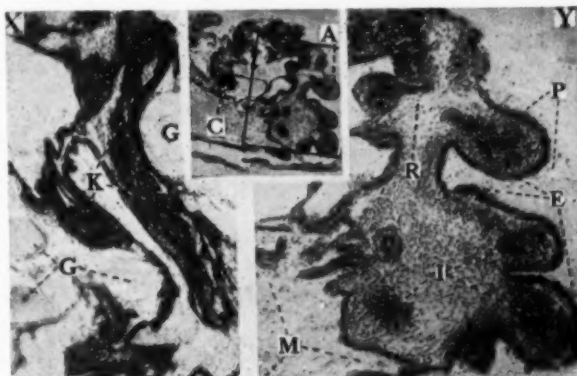


FIG. 11.—Case II. Photomicrographs of tissue removed at operation. The enclosed area in the upper central insert is from the wall of the cyst and presents the adamantinoma picture which is more clearly seen in the enlargement at the right (*Y*). The mass of stratified epithelium borders a connective tissue area (*M*). Its peripheral layer of columnar epithelial cells (*E*) is situated at right angles to the underlying zone of epithelium which shows tendencies to whorl formation (*I*). The central zone (*R*) is not strikingly differentiated (cf. Fig. 17, *V* and *U*). Note the delicate elevated membrana propria at *P*. The insert (*X*) at the left shows an unusual basal cell epithelioma-like differentiation present in another block of tissue of the same tumor. *K*=columns of deeply blue staining epithelial cells which lie next to dead masses (*G*) of keratinized epithelium. This basal cell picture was found in one small area in tissue from this case only.

which lies at right angles to those of the basal layer. Similarly the cells of the latter are at right angles to the subjacent epithelial cells.

The cells beneath the basal layer (the intermediate zone) have larger oval or nearly round, more lightly staining, nuclei, which tend to stain less strongly as the centre of the mass or process is approached. The cell bodies of this intermediate zone are somewhat flattened, with small but varying amounts of cytoplasm. In the central zone intercellular bridges are visible with the high power or else a varying degree of reticulation has taken place. In the latter case the cells consist of almost bare nuclei with thin protoplasmic processes, which stretch out and join similar ones of adjacent cells, often resulting in a "stellate" appearance of such individual cells. In case no reticulation exists, the cytoplasm is larger in amount, giving polygonal outlines to the cells. Such cells show clearly the intercellular spiculae or bridges.

Concentric-layered epithelial nodules (Fig. 11, *I*) lie in the convoluted processes of the mass or elsewhere in the intermediate zone below the basal

layer of cells. These appear to be the precursors of epithelial pearls, but show no keratinization. Their peripheral layers tend to be flattened, with dark nuclei, the cells centralwards becoming larger, with round, more lightly staining nuclei.

The epithelium which borders the large myxomatous area (Fig. 11, *M*) is a direct continuation of the peripheral basal layer of the above-described processes, but quickly loses its characteristic appearance and comes to consist of a double layer of cells which are flatter and contain much less cytoplasm than the typical basal cells. Also the basal layer of epithelial processes which

extend into underlying fibrous or myxomatous tissue tend to lose their typical appearance and become flatter. The myxomatous tissue shows a very loose structure, with fibroblasts and thin-walled capillaries. Besides there is a small amount of adult connective tissue present. Small cystic areas below the main epithelial mass are lined by flat epithelium, which in places extends across open spaces in a single layer of cells.

A single calcified vessel (Fig. 11, *C*) is present in the sections from this block. The wall shows a diffuse infiltration with lime salts. The lumen is filled with a homogeneous material in which the individual elements are fused.

Sections from the other blocks show quite a different variation of the structure above described, with a predominance of degenerative changes. Sections are made up largely of nests and processes of keratinized necrotic stratified epithelium (Fig. 11, *G*, and Fig. 12, *E*), in which a relatively slight but varying amount of calcification has occurred. When present the calcium salts deposit involves alone or more

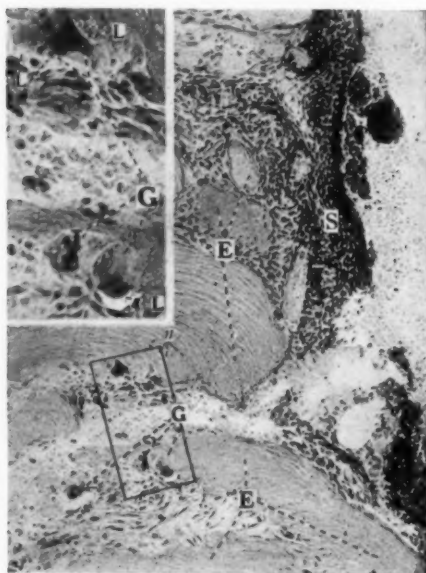


FIG. 12.—Case II. Showing phagocytosis of keratinized epithelium (*E*). *G* = foreign body giant-cells. Those lying within the squared area are shown enlarged in the insert above. Note that the giant cells (*G*) have penetrated the masses of dead epithelium and lie within lacunae. The phagocyte at the lower right corner of the insert is close applied to the dead tissue, a free space separating it from connective tissue cells whose nuclei take the stain. *S* = viable modified squamous epithelium showing neither typical adamantinoma nor basal cell characters. *N* = clear spaces of dead nuclei.

intensely the outer layers of dead epithelium. No ossification is present. A few larger nests or processes composed of viable squamous epithelium, resembling in their essentials those found in the preceding block, are present, but much of the live epithelium is present as attenuated processes (Fig. 11, *K*), which ring the periphery of dead epithelial masses. Only a suggestion is found of the sharply differentiated cylindrical basal cells, and these in no place assume the tall columnar character (Fig. 11, *E*) which is pictured above. Instead, much of the still viable epithelium shows as dense staining solid processes (Fig. 11, *K*) and nests which resemble the familiar picture of a typical basal cell epithelioma of the skin.

Lying in lacunae (Fig. 12, *G*) formed in the periphery of the dead tissue, closely rimming the contour of the same, or occasionally lying between the dead masses in the midst of the granulation tissue which fills such spaces, are large, irregularly shaped, foreign-body giant cells (Fig. 12, *G*). In the

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case of giant cells closely applied to the dead epithelium, either on the surface or lying in lacunæ, a concave surface is usually presented toward the dead tissue, small particles of which may be seen detached from the main mass and about to be enclosed by the encircling cytoplasm of the phagocyte. Other masses of dead epithelium surrounded by giant cells show a disappearance of a dust-like zone of calcification in the immediate vicinity of the phagocytes. This is striking, since calcification in undisturbed necrotic masses is usually more intense at the periphery of the mass. The latter calcified masses are usually surrounded by live epithelium, and no giant cells or fibrous tissue are in proximity to them.

The third and last block contains a small amount of the cyst lining with areas of calcification, large areas of recent hemorrhage, which show, owing to the formalin fixation, much hæmosiderin pigment change. But besides there is a more important small area about 0.4 in diameter composed of obvious hypophyseal anterior lobe element derivatives. These consist of chromophobe and eosinophile cells and a relatively normal amount of connective tissue. Chromophobe cells predominate. In general, traces of the normal structure are to be found in the fairly well-formed acini with delicate fibrous stroma. Marked pressure effects are to be seen in the flattening and convolution of such acini. The latter show no colloid, but in a few a lumen is present. In considerable areas no acini are to be made out, and the picture is of larger masses of cells, such as may be seen in anterior-lobe adenomata.

Summary of Case II.—A female child eleven years old, who had suffered with headaches of increasing frequency for five years, progressive failure of vision for one year, and occasional projectile vomiting for eight months, was brought to the hospital because of increasing disability and the recent appearance of stupor. Instead of retardation of sexual characters, there was perhaps slight exaggeration of same. Radiography showed a suprasellar nodular shadow, due to calcification; partial destruction of posterior clinoids, and separation of the fronto-parietal sutures suggesting a secondary hydrocephalus. At the exploratory craniotomy a suprasellar cyst containing 30 c.c. of fluid was evacuated and partly extirpated. Histological examination of tissue from the wall of the cyst showed definite squamous epithelial cell derivatives presenting the picture of adamantinoma. Death apparently from cerebral œdema. No autopsy.

(To be continued.)

THE TREATMENT OF CRANIOCEREBRAL WOUNDS AND ITS RESULTS *

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CRANIOCEREBRAL wounds in the recent war have differed greatly from those in previous wars. With the close-range firing of trench warfare and the development of more and more powerful explosive missiles, head wounds became not only more common, but also more serious injuries. The use of the steel helmet saved countless lives, reduced the total number of cranial wounds and rendered less mutilating many of those that have been inflicted.¹ Nevertheless, wounds of the head remained very frequent and very grave injuries.

Despite the teeming literature on the subject the evolution in the treatment of head wounds during the war did not, in a general way, parallel that of wounds of the chest, abdomen, and extremities. There developed a certain degree of uniformity of opinion concerning methods of procedure for wounds of these regions, whereas the end of the war saw no such uniformity in the treatment of craniocerebral wounds. The widely held impression that the ultimate results of severe head wounds were at best unsatisfactory discouraged any widespread interest in the subject. Furthermore, there was a general feeling that brain wounds as a class stood apart from wounds of other structures, and hence that their treatment should not be carried out along similar lines. Finally, relatively few of those engaged in military surgery had had sufficient experience in cranial surgery before the war; as a result, head wounds, as compared with abdominal wounds, for example, did not in general receive either the attention or the skill that their importance warranted. These are some of the reasons for the greater divergence of views on the management of craniocerebral wounds even at the close of the war, and, indeed, for the less perceptible advances that were made in their treatment. To the credit of American surgeons it can be stated that under the leadership of Colonel Harvey Cushing they contributed a real share to whatever progress has been made. This was arrived at not through the development of new or original methods, but by adoption and adaptations of the most desirable elements in the methods of Continental

* Read before the New York Surgical Society, April 14, 1920. The paper is part of a chapter in a forthcoming volume of Keen's Surgery, and the author is indebted to the Editor and the publishers for their kind permission to use this material.

¹ An appreciable proportion of the head wounds occurred in the temporal and occipital regions below the brim of helmets of the American or British models. Modifications of the brim to protect these regions would certainly have been a valuable added safeguard.

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surgeons. In what follows, the evolution of various methods of treatment will be described, procedures that appeal from personal experiences as most desirable will be more fully treated, and the immediate and distant results will be discussed, with a double purpose—to standardize as well as possible the treatment of craniocerebral wounds of modern warfare, and to indicate the applicability of some of the lessons acquired from war wounds to the head injuries and non-traumatic lesions of civil life.

Transportation and Place for Treatment.—The ideal place for the operative or other treatment of patients with head wounds is one somewhat further back from the line than the usual situation of evacuation hospitals. This viewpoint is held for the following reasons: Patients suffering from head wounds usually stand transportation well, even over long distances. This is true regardless of the severity of the wound if the pulse-rate is not greatly accelerated. Urgent indications for operation, such as active bleeding, are rarely present. Apparently infection does not spread as rapidly in head wounds as in wounds of the extremities, for example. Quiet is most desirable in the post-operative care of patients with head wounds, so that the place should, if possible, be beyond the zone of loud gunfire. The ideal hospital for these patients is one specially planned, equipped, and manned for their care; if that is not obtainable, separate wards for patients with head wounds should certainly be organized. Only in this way can they receive the particular attention they require after operation. Evidence has accumulated to show that patients with head wounds do not stand transportation well *after* operation, for the proportion of complications appears to have been distinctly higher when patients were transferred to base hospitals shortly (within ten days) after operations for severe wounds. Therefore, the ideal hospital plant would be one in which such patients could remain for several weeks or even longer. Unfortunately, very few of these ideal requirements could be attained during the war, especially with the shifting fronts of its later phases. The fact that such arrangements were generally absent in the front area and that patients with head wounds travelled well before operation led (especially in the British lines) to the evacuation of the wounded for their primary operations to base hospitals many miles distant. The unsatisfactory results in the treatment of head wounds under such circumstances was ultimately recognized, for it was found that patients often arrived at base hospitals with wound infections ineradicably established.

Classification of Wounds of the Head.—Many of the classifications that have been advanced were based on pre-war ideas, in which the skull and not the brain injury had been considered the dominant feature of the wound. It may be going too far to say that the classical teaching concerning lines of fracture in gunshot wounds went for naught, but certainly a detailed knowledge of the bending and bursting radiations of the skull injury was no essential requirement for the surgeon. Other classifications pivoted on physical signs and symptoms; these were unsatisfac-

tory, for it was found that patients with wounds involving the brain might walk long distances and appear perfectly fit, whereas others in coma with many signs of serious damage might present trivial lesions at operation. There were also too many other factors affecting the general condition, such as battle exhaustion, starvation, or fear, to have made such a classification tenable.

The greatest single element that determined the seriousness of a head wound was the *condition of the dura, whether penetrated or not*. In other words, the decisive factor was *whether or not the chief portal for the development of intracranial infection had been opened*. The best classification is, therefore, one that hinges on this fact. Using such a classification, wounds of the head can only be placed in various categories at operation, since the external appearances of wounds often give such little information about the extent or situation of deeper lesions. Cushing employed the following grouping of head injuries according to their severity, stressing particularly the condition of the dura. His figures for the operative mortality of the various groups are added²:

- Grade I. Wounds of the scalp with intact cranium and dura. Mortality, 4.5 per cent.
- Grade II. Wounds producing local fractures of variable types, with dura intact. Mortality, 9.2 per cent.
 - Type A. Without depression of external table.
 - Type B. With depression of external table.
- Grade III. Local depressed fractures of various types, with dura punctured. Mortality, 11.8 per cent.
- Grade IV. Wounds, usually of gutter type, with detached bone fragments driven into the brain. Mortality, 24 per cent.
- Grade V. Wounds of penetrating type with lodgment both of projectile and bone fragments. Mortality, 36.6 per cent.
- Grade VI. Wounds with ventricle penetrated or traversed.
 - A. By bone fragments. Mortality, 42.8 per cent.
 - B. By projectile. Mortality, 100 per cent.
- Grade VII. Wounds of craniocerebral type involving
 - A. Orbitonasal
 - B. Auroptrosal region
 } Mortality, 73.3 per cent.
- Grade VIII. Wounds with craniocerebral perforation. Mortality, 80 per cent.
- Grade IX. Craniocerebral injuries with massive fracture of skull. Mortality, 50 per cent.

Unless very complicated no classification of head wounds can be

²What is termed "bursting fracture" corresponds to Grade IX in Cushing's classification. Mention of Cushing's Grade VII is omitted, because cases he has placed in that group appear to me to fall more naturally in one of the other grades, depending on their characteristics.

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free from a certain amount of overlapping. I have employed a simpler classification, which offers perhaps the added advantage of less overlap, in which each group is arranged in the order of increasing severity:

1. Scalp wounds.
2. Cranial wounds—dura intact:
 - (a) Simple fracture.
 - (b) Depressed fracture.
 - (c) Bursting fracture.
3. Craniocerebral wounds—dura torn:
 - (a) Depressed fracture.
 - (b) Tangential:
 - (1) Ventricle intact.
 - (2) Ventricle penetrated by bone fragments.
 - (c) Penetrating (metal retained):
 - (1) Ventricle intact.
 - (2) Ventricle penetrated by missile.
 - (d) Perforating.

There are a number of other factors influencing prognosis that enter into either of these classifications, but their inclusion would only serve to complicate the general outlines above given. A few may be mentioned: The degree and nature of contamination or infection of the wound; existence of other serious wounds; physical condition of the patient; terrain of the battle area.

Symptoms and Physical Signs in the Recently Wounded.—A careful local, general, and neurologic examination should be made in every head wound. The reason for the local and general examination is evident. Since it is undoubtedly true that the neurologic manifestations rarely decide the question of operative intervention, its threefold purpose should be stated: (1) To estimate the extent of the cerebral lesion. (2) As a guide for the interpretation of post-operative complications or improvement. (3) For future reference in connection with functional results, late complications, and sequelæ.

Too much emphasis cannot be placed on the fact that the local appearance of the wound is not a guide to the extent of an underlying lesion of the brain or even of the skull. In a considerable proportion of the cases the physical signs and symptoms are very similar whether the wound be superficial or deeply penetrating. A scalp wound, to all appearances superficial, may mask a deeply penetrating wound of the brain. A patient in coma may have nothing more than a chip fracture of the skull, whereas the next patient, mentally alert, may be suffering from a ventricular penetration. To be sure, a man with a deep gash of the head from which brain substance is extruding is severely wounded. But even his lesion may not be as serious as one in which there is a slit-like pene-

trating wound, where damage of the brain, although invisible, may be much more extensive. Positive evidence of brain injury, such as paralysis or hemianopsia, can be evaluated, but negative evidence is worthless either in the diagnosis, the prognosis, or the indications for treatment. Few or many symptoms and physical signs of cerebral injury may be present in patients suffering from craniocerebral wounds. The following symptoms and signs of those that occur, therefore, should not be understood as manifestations regularly present in the seriously wounded:

Local Signs.—*Hemorrhage* from a wound of the head is rarely observed except on the battlefield. In the great majority of cases there is little or no oozing of blood by the time the patient arrives at a dressing station or evacuation hospital. This is true even when venous sinuses have been torn across by missiles or fragments of bone. Hemorrhage from injury to the middle meningeal artery is very unusual; indeed, contrary to expectation, extra- or intradural blood-clots of large size are rarely found at operation. The only active hemorrhage I saw from a cranial wound admitted to the front area hospital was one from a divided temporal artery. Of course, bleeding from the ears or nose occurs in head wounds with fractures radiating to the base.

The Wound.—Enough has been said concerning the wound itself to indicate clearly the unreliability of drawing any conclusions from it. In many instances the patient enters the hospital with a wound covered by hair matted together by blood-clot and dirt. Only after the head has been shaved will the characteristics of such a wound be apparent. And only then may one or more other wounds of the head that had not been previously suspected be discovered. Finally, at operation the evident wound may turn out to be a simple scalp lesion, whereas the minute, easily overlooked punctured wound may be the entrance of a missile penetrating the brain. Multiple cranial wounds are common or rare, depending on the type of warfare. In the Passchendaele campaign of 1917, when shellfire was employed almost exclusively, I saw multiple wounds very frequently, whereas they were not common with the extensive use of machine guns in the Argonne.

It is futile to make any effort to describe the infinite variations in the appearance of head wounds. Tangential and perforating craniocerebral wounds and "steel helmet" wounds may be selected for special mention. Before the recent war *tangential* (gutter) *wounds* aroused little interest, probably because of their less significance with the lower velocity missiles of those days. Tangential wounds were common and caused serious lesions in the recent war. The wound is generally a characteristic one. The furrow or gutter that is cut through the soft parts is of varying lengths and generally wider in proportion to length than in other types of wounds. A striking feature of tangential wounds is that, if severe enough to involve the dura, brain substance almost invariably presents

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in, and extrudes from, the gap. Another equally characteristic feature observed at operation is that bone fragments, frequently of large size, are driven into the brain at right angles to the wound. Short through-and-through (perforating) wounds in which the missile has struck the surface of the skull in transit or has tangentially traversed the skull are included in the group of tangential wounds. *Perforating* (bipolar or through-and-through) wounds are the most fatal of craniocerebral wounds, owing to the tremendous brain damage that is inflicted. They also form the group for which the least relief can be obtained by operative measures. The fact that the cranial cavity has been perforated by rifle or machine-gun bullets may be readily overlooked and the wound of exit can easily be mistaken for the *only* wound. This is particularly apt to be the case if the minute entry wound is in an unusual situation, such as the nape of the neck or within the auricle. The term "*steel-helmet wounds*" should, I believe, be given to head wounds that are the direct result of wearing this head protector. There are three types that I have noted. In one the helmet has been traversed by the missile and a sharp edge is turned in to be lodged in the skull. The dura may or may not be penetrated. In another the helmet has been driven down on the head, producing a contused or lacerated wound of the scalp, generally in the frontal region. Localized fractures have existed under these lesions in several instances I have seen; in addition, there may be one or more lesions the direct result of missiles. Finally, the skull may be shivered into numerous radiating fractures by the impact of a projectile transmitted by the helmet. A striking feature is that slight, if any, abrasions or lacerations of the scalp are usually found under such circumstances. Such cases belong to the group of bursting fractures. Many of them cannot, of course, be proved to be the result of the force transmitted by the helmet. There are a number of authentic instances, however, and I have seen one in which the deeply dented helmet was brought into the hospital by a companion of the wounded man.

X-ray examination is an absolutely indispensable form of examination of a head wound. Under usual circumstances an operation should never be undertaken without it; in times of stress it has, unfortunately, been necessary to forego the aid derived from röntgenograms. Given, for example, a wound with extruding brain substance, and the difficulties involved in an operation without previous X-ray examination are evident. Not knowing whether the wound is penetrating or tangential, one is forced to grope about for a projectile that may not have entered the brain or may have penetrated in a different direction from the one in which it is being sought. The dangers from such unnecessary trauma need not be dilated upon. Exact localization of foreign bodies is not the only assistance X-ray examination gives. The existence of depressed fractures is established. When skull fragments are driven into the brain, their number, size, and depth of penetration are determined; this is of

great importance to the surgeon at the time of operation.³ In a consecutive series of 45 cases I checked up carefully the interpretations of stereoscopic pictures that had been made; these exactly described the findings at operation in regard to size, position, and number of bone fragments and missiles in 44 of the 45 cases. If X-ray pictures cannot be taken, fluoroscopic examinations are of great aid in localizing the situations of fragments of metal, or in determining their absence. During many months' work in a mobile hospital I had to depend entirely on fluoroscopic examinations, and their reliability is, in my opinion, definitely established; but the assistance they give the surgeon falls far short of that derived from X-ray plates.

General Symptoms.—Loss of consciousness is common whether the wound is slight or severe. It is of very varying duration, from a few minutes to several days. Stupor or semicoma often alternates with a peculiar restless irritability, making patients exceedingly difficult to manage. Either coma or this irritability is of serious omen if it has lasted a number of hours. In a series of 100 cases admitted to a front-line hospital where I was stationed, and in which admissions averaged ten hours after injury, 37 per cent. entered in one or the other of these conditions. Only 30 per cent. of those in coma or semicoma, and 60 per cent. of those with restless irritability, recovered. Early in the war a slow pulse was interpreted as indicating cerebral compression. Subsequently, this was found to be incorrect. A slow pulse is often associated with battle fatigue or with inanition, and the pulse is not infrequently rapid with cerebral involvement. In fact, a greatly accelerated pulse is of grave significance; upon examination of my records I find that there was not a single recovery where the pulse-rate on admission was 130 or more, whether operation was performed or not. Headache is the most common complaint of patients entering the hospital; it is generally frontal, regardless of the position of the wound, and bears no relation to the gravity of the wound. Other symptoms, such as vomiting, vertigo, vasomotor disturbances, and so on, occasionally occur.

Neurologic Manifestations.—Detailed descriptions of the many interesting and significant neurologic observations that have been made in patients suffering from head wounds would take too much space and must be sought elsewhere. In brief, it may be said that evidence of brain injury is afforded by disturbances of motor, sensory, reflex, and visual functions, depending upon the region that has been involved. The important point is that these disturbances are not necessarily due to destruction of brain tissue by the wound, but may be, and often are, in small or greater part, the result of contusion or œdema of the brain about the wound. This explains the surprisingly frequent recovery of function

³ The X-ray picture cannot be entirely depended upon to establish the presence or absence of slight fractures without much depression, owing to normal irregularities of the shadows.

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after head wounds, a recovery that cannot, of course, be ascribed directly to operations that have been performed.

From the foregoing it is evident that neurologic examinations are often difficult and not infrequently impossible of execution in some of the wounded. The presence or absence of gross paralyses and changes in the eye-grounds can, however, almost invariably be determined. The most striking neurologic feature of recent head wounds has been, I think, the relative infrequency of paralyses even when wounds were in the regions in which one would expect them. Thus, in the series of 100 cases, massive hemiplegias with or without aphasia were present in only 7 per cent. and pareses in 9 per cent. An interesting feature, brought out by Dr. L. J. Casamajor in the study of this series of cases, was that the epigastric, abdominal, and cremasteric reflexes were often reduced and sometimes absent on the side opposite to the head wound, even when there were no other evidences of cerebral involvement in the neurologic examination. Cranial injuries having been subsequently found at operation in such cases, the demonstration of reduction or absence of these reflexes, I believe, is of definite value in indicating craniocerebral injury by gunshot wounds. Examination of the eye-grounds is generally of little value. They often show no changes with the severest wounds. Definite choking of the disks is very uncommon. Slighter alterations, consisting in dilatation with occasional tortuosity of the veins and blurring of the disks, are only present (with rare exceptions) in cerebral involvement, and are of value to that extent. Changes in the fundi are most often found in depressed fractures without extrusion of brain substance.

This brief discussion of neurologic signs cannot be left without reference to the so-called "longitudinal sinus syndrome" described by Sargent and Holmes. This striking picture, a rather frequent one accompanying wounds over the midline in the parietal region, consists in a spastic paresis or paralysis of one or both lower extremities, extending to the arms in severe cases. Sargent and Holmes believe the condition to be due to lesions of the longitudinal sinus or of veins entering it. Unquestionably an injury of the vessel frequently coexists, but in the uniform presence of damage to the adjacent paracentral lobes I can see no good reason for attributing the neurologic manifestations to the sinus lesion. I may add that no lesion of the longitudinal sinus or of the vessels entering it was found at autopsy in two patients in whom the syndrome had been present.

Indications and Time for Operation.—These aspects of the subject of craniocerebral wounds were the source of much discussion and wide divergence of views during the war. The question of the indication and the equally important one of the time for operation are intimately linked. It is patent that the indications for operation when the patient is seen two or three days after injury are totally different from those existing shortly after he has been wounded. Yet this basic difference

was not generally recognized until the latter part of the war; the result was a confusion of ideas and, unfortunately, the loss of many lives. The purpose of operation in the recently wounded is the elimination of infective material; the chief indication for operation at later stages is the control of infection. In the earlier part of the war operations at front-line hospitals generally consisted in enlargement of the wound, elevation of bone fragments, drainage of brain tracts, etc. Such operations, instead of eliminating infection, established septic wounds and hernia cerebri in many cases. The general impression that resulted was that operations should not be done in the front area, particularly when it was noted that cases arriving not operated on at the base usually ran a more satisfactory course. Only when the correct operation for recent head wounds—one to eliminate contamination—was evolved could opinion logically veer to early operation. Toward the end of the war there was fairly general agreement that the time for operation on craniocerebral wounds was the time for operation on other wounds, and that the main indication for operation on head wounds was the same as in other wounds.

The indications for operation, then, are clear in wounds definitely involving the brain. From what has been said of the ever-open question of deeper involvement in apparently superficial wounds, the indication for operations under such circumstances is exploration. Even though a patient walks without difficulty, does not suffer from any symptoms, has no neurologic signs of injury, is, in short, fit in every way, his scalp wound should be explored as the only means of determining if there is any deeper damage. Cerebral compression from blood-clot is, as has been said, so unusual an occurrence that it need only be mentioned in passing as a rare indication for operation. It has already been noted that neurologic manifestations may be due to destruction of brain substance or œdema and contusion, or to both, and it is impossible to differentiate between these conditions. Therefore neurologic symptoms and signs are not in themselves indications for operation. No matter how severe the cerebral lesion, the patient should be given the chance of operation if there is any likelihood of his withstanding it. The surgeon is not the judge of whether a life is going to be worth while living, so long as there is a chance of the life being spared. Besides, like others, I have had the agreeable surprise of witnessing not only recovery, but also recovery with good function in apparently hopeless cases.

As already stated, the indications for operation on head wounds at later stages, as seen in base hospitals, are totally different; they will be discussed after taking up the operative technic for, and complications following, recent wounds.

Contraindications to Immediate Operation.—An operation for a head wound should not be done at a front area hospital unless it can be adequately performed. This involves a satisfactory armamentarium, arrangements for good asepsis, and the reasonable assurance that pa-

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tients with severe wounds can remain for at least a week after operation. Operation is contraindicated in manifestly hopeless and moribund cases. It is not indicated, or should at most consist in local toilet of the wounds, in the great majority of perforating craniocerebral lesions. In bursting fractures with insignificant wounds operation is usually not required; if necessary, it consists in a subtemporal decompression. The complete operation to be described is contraindicated in large multiple scalp wounds without evidences of depressed fracture because of the difficulties in closing the scalp under such circumstances. Finally, operation is inadvisable, in the absence of symptoms, in penetrations by very small fragments of metal when the wound of entry is not soiled.

The Operation for Recent Craniocerebral Wounds.—The evolution of the operation for wounds of the head has already been indicated. Wounds were at first freely incised, bone fragments elevated or removed, and brain tracts drained. After the unsatisfactory results of such procedures became recognized the general plan was to defer the treatment of cranial wounds until arrival at base hospitals. Here various methods of flap operations with drainage of brain tracts were evolved; the results were, on the whole, unsatisfactory, but better than the incomplete operations done at the front. A later development, as a consequence of frequent failures by the foregoing methods, was the attempt, both in front-line hospitals and at the base, to secure primary union after excision of the wound. But the principles of *débridement* were not yet established, excision of the wound was accordingly incomplete, and the results were still far from acceptable. The pioneer work of French surgeons (particularly Lemaître) and of Depage and his co-workers in Belgium definitely settled the methods for *débridement* of wounds in order to insure primary union after suture. There remained the necessity for the application of these principles to cranial wounds. A special adaptation was, of course, necessary, for brain tracts could not be laid open and excised. In fact, the term "*débridement*" strictly applied to a craniocerebral wound is a misnomer, because brain tracts cannot be so treated. Happily, the deeper portions of craniocerebral wounds generally appear to be less contaminated by bacteria and foreign matter than wounds of other regions because of the combined obstacle offered by the scalp and skull. It was the modified treatment of brain tracts along the lines of *débridement*, together with the true *débridement* of the portion of the wound involving soft parts and bone, that led to the best results obtained in operations for craniocerebral wounds.

These are, in a general way, the stages through which operations for head wounds passed. However, there were individual surgeons, mainly French, who practised fairly complete operations with primary closure long before the method was widely accepted. The work of De Martel should be particularly mentioned in this connection, for he persisted along these lines almost from the outset of the war.

Before describing the steps of the operation it may be well to mention the fact that the wound of the head is often only one of many wounds. In an analysis of the first series of 100 cases I treated, the great majority of the patients had wounds other than cranial. These wounds were serious in 11 per cent. of the cases; there were, in addition, 4 cases in which they were the cause of death. The point is that such other wounds cannot be slighted because of concentration on the head lesion at operation; I know that there were at least 2 cases in my experience in which death ensued from infection in these other wounds, most likely the result of the inadequate operations that were performed. The average duration of an operation for a craniocerebral wound is somewhere between an hour and a half and two hours. Therefore, another surgeon with his assistants should operate simultaneously on the other wounds if the latter require prolonged procedures. Furthermore, it sometimes becomes a matter of careful judgment whether or not to defer operation on the head wound in the presence of another serious wound urgently requiring an extensive operation.

Preparation of the Scalp.—The entire scalp should be shaved for a number of reasons. It is impossible to say in advance how extensive an exposure will be needed. Other wounds may be disclosed. Various wide-sweeping plastic incisions may be required for scalp closure. Cushing objects to preparation of the skin with iodine because it is apt to be followed by crusting and scaling, but I believe that that objection is outweighed by the advantages inherent in the penetration of the dried scalp by iodine. He also advocates the application at the field ambulance of a warm soap poultice to the wound, a procedure that is inadvisable, I think, because it would be apt to be a chilling dressing by the time the patient arrived at the hospital. In some French units the scalp was close cropped before the men went into action. This admirable precaution may very well have lessened the infectivity of not a few cranial wounds and certainly rendered less difficult the trying task of shaving the scalp.

Anæsthesia.—The use of local anæsthesia in operations for head wounds was developed chiefly by French surgeons, De Martel in particular. The objections to general anæsthesia are: Increased intracranial tension encountered at operation, with a resulting tendency to herniation of the exposed brain and forcible expulsion of the contents of a brain tract; increased bleeding from the scalp and bone, as well as from cerebral vessels; the tendency to the development of respiratory complications after operation; the necessity for careful observation of the patient until recovery from the anæsthetic, and, of course, the necessity for a skilled anæsthetist. The advantages of general anæsthesia are: Reduction in time consumed in preparation for operation, and the elimination of the difficulties in shaving restless patients. But these are counterbalanced by the many desirable features of local anæsthesia. Besides overcoming these objections, local anæsthesia is apt to encourage gentler and more accurate

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methods; the patient can be operated upon in a semi-sitting posture (De Martel); he can often coöperate by changing the position of his head when desired, coughing or straining to help express the contents of the brain tract, and so on. Local anæsthesia cannot be satisfactorily employed in some of the patients suffering from the peculiar restless irritability that has been described. Unfortunately, shaving and anæsthetization of the scalp are time consuming, and when many cases have to be operated upon and there is not at hand the assistance required for the preparation of succeeding cases while the surgeon and his team are operating, resort must be had to general anæsthesia.

It is generally advisable to administer some narcotic before operations under local anæsthesia. Omnopon was extensively employed by British, and scopolamine by French surgeons. One per cent. novocaine with adrenalin (added in the proportion of 1 c.c. to 30 c.c. novocaine) is injected about the area of the wound and along the lines of the proposed incision. If sufficient time is given for this to take effect, additional infiltration with the anæsthetic is usually unnecessary during operation.

Excision of Scalp and Bone.—This part of the operation, as practised by De Martel and other French as well as British surgeons, consisted in turning down a large osteoplastic flap with the wound in its centre, and subsequently excising the wound tract. The objections which I believe to be inherent in flap methods are: Unnecessary difficulties in technic; the need for huge flaps with the larger wounds; the manifest undesirability or impossibility of flaps in certain regions; difficulties in the treatment of post-operative infections, especially hernia cerebri, should they arise; and difficulties in scalp closure after excision. The principle of simple excision of scalp and bone was, therefore, evolved, dependence being placed upon one of a number of methods of plastic incisions if required for closure of the scalp. The method employed by Cushing was an incision about the wound with three radiating ("tripod" or "Isle of Man") incisions extending from this. By reflecting these flaps adequate exposure of the skull was obtained. In the ordinary type of wound I generally employed a simple long, elliptic incision circumscribing the wound, placed to give the necessary exposure in the desired direction. The ends of this incision were curved one way or another to permit the scalp to be reflected where greatest exposure of the skull was required. The incision employed by Cushing was designed, of course, not only for exposure, but for subsequent plastic closure. I believed that the necessarily extensive reflection and undermining of flaps was undesirable if post-operative infection should supervene, and that the junction of three flaps at one point overlying exposed brain invited infection of the brain and the development of hernia cerebri, should there be any infection in and separation of the scalp wound. As will be subsequently indicated, plastic incisions were not infrequently required for closure after the simple elliptic incision, but I believed that the time for their consideration (as

in breast amputations for carcinoma, for example) was at the end of operation. After all, the important point is that, in accordance with the principle of débridement, the wound should be completely circumscribed, not omitting the minutest visibly devitalized or soiled portion of scalp. In the beginning unnecessarily wide areas of scalp were sacrificed, until it was learned that the incision could safely be placed a few millimetres from the margin of the wound. The incision is deepened to bone, all devitalized areas in the soft parts being circumscribed.

The excision of the depressed fracture consists in making a number of small perforations in the skull immediately beyond the bony lesion, and connecting them with linear cuts through the bone. Forceps of the De Vilbiss pattern may be used for the latter, but the Montenovesi forceps is best adapted for the purpose. It makes an excellent linear cut, can be introduced through smaller openings, turns corners more easily, and is less jarring. After the perforations have been joined up, the section of bone is uptilted and scalp and bone are thus removed in one piece. The advantages of this technic are evident. The soiled area is removed in one piece, there is immediate exposure of the underlying lesion, and the mosaic of bone fragments can be examined to see if it is complete. The first point requires no elaboration. The complete exposure that is immediately obtained is particularly advantageous in sinus lacerations, for otherwise removal of a fragment of bone lodged in such a sinus, before the field has been adequately bared, generally leads to hemorrhage that is difficult to control. By possessing the mosaic of bone fragments one can determine if any parts are missing, and accordingly seek them.

This type of block excision was, therefore, strongly urged by Cushing. Although admirable for many varieties of wounds, I found some objections to its routine application. In the first place, it cannot be readily employed in wounds toward the base of the skull, such as those involving the mastoid. In cases in which damage to the skull is merely suspected, or when a superficial bone lesion is anticipated, I believe areas of skull are unnecessarily sacrificed thereby.⁴ In such instances I think it better to excise the scalp wound with periosteum and then examine the bone. When extensive depressed fracture exists, block removal of bone can be carried out. If there is a superficial chip fracture, a perforation of the bone can be made to one side, and the involved portion of the skull is then lifted out with a rongeur forceps. The latter is discarded and fresh rongeurs used should the opening require enlargement for the removal of depressed fragments of inner table or for the treatment of a dural tear. Another objection to block removal of skull is that, in that method, the lesion of the outer table is the guide to the amount of bone to be removed. As is well known, fracture of the inner table is often more extensive and the

⁴The removal of any more of the skull than is required for the débridement or adequate exposure is no small matter; as will be shown, the question of repair of defects often arises at a later date.

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depressed fragments cover a broader area than would be indicated from the fracture of the outer table. In such instances the block removed may well include only parts of the inner table; I recall two instances in which I inflicted unnecessary trauma by depressing fragments of the inner table with the jaw of the bone-cutting forceps under these circumstances. Furthermore, a superficial tear of the dura may be converted into a deeper one upon tilting the block should a pointed fragment of bone be firmly locked in the dura. These objections are not to be understood as outweighing the advantages of block removal, but as indicating what I believe to be its limitations.

A different technic which I have used in many cases may be described as follows: After excision of the scalp with its periosteum, a perforation is made to one side of the bone lesion. With rongeurs and linear cutting forceps the bone is cut away progressively along the margin of the fracture. If more extensive inner table depression is found, the bone is removed widely enough to expose this completely. After the rim of bone about the fracture has been excised, a blunt elevator is used to separate the depressed fragments from the dura. The mosaic is removed in one piece when it appears safe to do so. However, when the lesion is in proximity to a venous sinus, when fragments are firmly attached to the dura, or when a dural tear is suspected, the fragments are lifted out in small sections. In suspected sinus injury removal of fragments is begun away from the sinus region, so that the exposure is adequate and preparations complete to treat a sinus tear upon removing the last fragments. The instruments used for the removal of the mosaic are soiled and therefore discarded. With large defects in the skull, as in tangential wounds, this technic is also very satisfactory for débridement of the bone. Although not as neat as block removal, I consider the method safer under the circumstances that have been indicated; it is always simple of application and attains the same ends as removal *en bloc*.

Whatever technic of débridement is employed, the resultant exposure should be sufficient for the treatment of the underlying lesion. With large dural tears enough bone must be removed to completely expose normal dura all around, except in those regions (tears going down toward the base) in which this is not feasible. Linear fractures radiating from the cranial penetration are not followed except when bone removal along them is required for the exposure of a lesion underneath.

Treatment of the Intact and Torn Dura.—Any blood-clot adherent to the dura may be contaminated and is therefore gently curetted away. The question of incising an intact dura not infrequently arises when its surface is discolored, tense, and not pulsating, especially if paralysis or other functional loss exists. It is always a difficult question to settle in the presence of a soiled wound. Some hold that an intact dura should never be incised; others, that it should be invariably opened if indicated for the removal of blood-clot or disorganized brain. Surely the dura

should not be incised under any circumstances unless one is certain of the operating-room asepsis, of the débridement of the wound, and of the uncontaminated condition of the part of the dura it is proposed to open. The possible or even probable advantages of incising the dura must always be weighed against the ever-present possibility of a fatal infection that may result. It is impossible to draw any definite conclusions in favor of or against incision of an intact dura from the literature on the subject, because most writers fail to give facts to support their assertions. In my own experience the dura was not opened in any of the cases in which it was intact, although in a number there were definite evidences of underlying damage. *There were no deaths.* Recovery from paralysis or other loss of function was perhaps slower than it might have been with incision of the dura, but the follow-up notes show a satisfactory outcome in all the cases.

A dural tear is generally large enough for the exploration and treatment of an underlying brain tract; if not, it must be opened to the required extent. Most surgeons contend that the margins of the torn dura should be left undisturbed, the argument being that otherwise adhesions are separated and an infection of the meninges invited. I hold that an adequate débridement includes removal of the devitalized margin of the dura (1 or 2 millimetres) as a necessary step, and I have seen no meningeal complications referable to such excision. When the head wound is definitely infected the stage for true débridement is, of course, past, and the sealed-off meninges must be respected. But in the earlier period every effort is bent toward obtaining primary union, and excision of the dural margin is part of the procedure. It is usually attended by fresh bleeding readily controlled by ligating one or two vessels with fine silk. Débridement of the dural margin is best done after the toilet of the brain tract.

Treatment of the Brain Tract.—This is the most important single step in the operation in wounds with cerebral penetration, for the removal of the cerebral débris, blood-clot, bone fragments, and bits of cloth plugging the tract means the elimination of the greatest factor favoring brain infection. Fortunately, a considerable portion of the contents of the tract will frequently extrude spontaneously (or after removal of superficial fragments corking the tract) if the patient can be made to cough or strain, or with the increased tension that usually exists in general anæsthesia. The method generally used for removing deeper bone fragments, until Cushing introduced catheter suction, consisted in the insertion of a finger to dislodge bone fragments, alternating this with irrigation of the tract. These procedures were repeated until the tract was free from bone fragments and débris. Unquestionably digital exploration may inflict damage to the walls of a brain tract, even when done with the greatest gentleness. Therefore, Cushing's technic is a real contribution, since the tract is well and safely cleaned thereby and the use of the finger is eliminated.

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It is employed as follows: "Reliance was placed on the use of a flexible, soft-rubber catheter as a means of determining the exact direction taken by the missiles, whether a metallic body or bone fragments, or both. Without the production of additional trauma one may investigate in this way even the narrowest tract, and it will be found that the presence and situation of any in-driven bone fragments can be detected with almost as great delicacy as by direct palpation. By attaching to the end of the catheter a Carrel-Gentile glass syringe with its rubber bulb it is possible to suck up into its lumen the softened brain, which can then be expelled from the catheter as paste is expressed from the orifice of a tube. The process should be repeated until the cavity is rendered as free as possible of all the softened and infiltrated brain. It will be found that the adjoining normal cerebral tissue, unaffected by the original contusion, will not be drawn into the tube by the degree of suction which can be applied by the average rubber bulb. Not infrequently bits of bone come away in the eye of the catheter, and on one or two occasions a small foreign body has thus been withdrawn. Meanwhile, as the track becomes clean and the tension and tendency of the brain to herniate subsides, it is possible with delicate duck-billed forceps to pick out from the track one by one the bone fragments, whose depth and position can be determined by the unmistakable sensation they impart to the catheter, which thus supplements the information given by the X-ray plates. The technic of the performance will quickly be acquired by any one who may wish to put it into practice."

Before this technic was described I had always explored digitally those brain tracts wide enough to admit the finger freely, reserving the instrumental extraction of bone spicules, débris, or foreign bodies for the narrower tracts. Entirely converted to the routine use of catheter suction, I see no objection and one real advantage in additional palpation of such large tracts, *provided it is done carefully*. My usual procedure in these wider tracts has been painstakingly to cleanse the track with alternate flushing and suction through the catheter, using delicate forceps to remove the bone fragments felt with the tip of the catheter. When the tract has been rendered as clear as possible a finger is introduced and the walls are palpated for any embedded bone fragments that may have been missed. Upon a number of occasions I have found and dislodged such fragments in this way. In fact, bone fragments buried in the wall of the tract can be felt with the catheter only by the merest chance. When felt, it has been safer in my hands to dislodge them with the finger rather than to use an instrument that may readily traumatize surrounding brain tissue.

Although single brain tracts are the rule, it should not be forgotten that two or more fragments of metal may enter through one skull opening (or the missile may be split up in transit through the skull) and

penetrate the brain in different directions. The X-ray would, of course, indicate the existence of multiple foreign bodies in the brain, but it is not apt to establish penetration through a single skull opening. I recall an instance of double penetration, with the parallel tracts not far apart, and again, a single penetration with three forking tracts in a case with multiple scalp wounds. One must, therefore, be on the watch for multiple tracts in order to avoid missing minor ones; larger penetrations could scarcely be overlooked. Minor tracts require the same detailed attention as the wider, more evident penetrations.

There is no essential difference in the treatment of the tract in the more serious cases of *ventricular penetration*. Until catheter suction was employed the existence of this condition was usually only surmised at operation from the path of the missile, or was found after death. With catheter suction the diagnosis is promptly made by drawing cerebrospinal fluid up into the syringe. Bone fragments should be extracted from the tract even more carefully than ordinarily for fear of dislodging them into the ventricle. The ventricle can be sucked dry. In wide tracts two long, thin-bladed retractors may then be introduced and inspection made of the interior of the ventricle with reflected light to discover bone fragments or a missile in the cavity. There appears to be a definite tendency (because of the resistance of the fluid) for foreign bodies that have penetrated the ventricle to be retained there rather than to become embedded in brain substance beyond. Their retention in the ventricle is almost sure to be fatal, and therefore every justifiable effort should be made toward extracting them. Fortunately, not a few ventricular penetrations are the result of puncture by one or two long slivers of bone that can be easily removed.

Before catheter suction was introduced ventricular penetration was thought to be a hopeless lesion. We now know that the mortality from penetration by bone fragments is not much higher than when the ventricle is intact. The rôle of dural repair in the results that may be obtained will be subsequently noted. Cases in which the missile penetrates the ventricle appear to be quite hopeless; however, I have had one undoubted case that recovered after operation.

Treatment of Devitalized Brain Tissue.—This aspect of the treatment of the cerebral wound is not usually discussed by writers; yet it is a definite step in the technic. Manifestly the devitalized portions of brain around the cerebral tear should be subjected to débridement as a necessary element in the effort to avoid infection. They are apt to slough and are already contaminated. Snipping off dangling fragments does not suffice. Devitalized fragments should be removed freely enough to obtain some oozing from the surface that is left. It is clear that serious functional loss may occur if one cuts widely into healthy brain substance. By closely hugging the devitalized fragments with a sharp scalpel or fine-pointed scissors no harm will be done. Partially detached tags of pia-

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arachnoid are generally found where there is much cerebral laceration, and they, too, should be ablated.

Extraction of the Missile.—Subsequently it will be shown that the retention of a missile in the brain is not the essential element in the development of late complications after craniocerebral wounds. Yet the extraction of the foreign body is eminently desirable not only for the elimination of an important element favoring sepsis but also because infective material about the missile and in the tract leading to it is thereby removed. The ideal time for extraction of the foreign body is at the primary operation, for there then exists a tract acting as a guide to its situation. In extractions at a later date cicatricial tissues (or normal brain) must often be traversed, and there is greater likelihood of injuring adjacent brain substance. "Latent sepsis" has been lit up, according to some reports, in late foreign body extraction. Therefore, every reasonable effort should be made to extract the foreign body at the primary operation. When superficially situated in the brain, this is a simple matter. There has been considerable difference of opinion concerning the advisability of the removal of deeply implanted missiles, some urging that they should be left alone. I believe a middle ground between these extreme views is the justifiable position to hold, namely, that every reasonable attempt should be made to extract the missile, always provided that serious damage to the brain be not inflicted by the manoeuvres.

Small fragments of metal are not infrequently drawn into the eye of the catheter in the suction method, and removed in this way. After the tract has been freed of debris a foreign body sometimes becomes freely exposed at the apex and can be readily removed. Magnet extraction is usually required for deeply seated missiles. The safest method consists in gently introducing a slender rod (made specially for that purpose) to the bottom of the tract (the length and direction of the tract are determined by the catheter and the position of the foreign body by the X-ray) and then making contact with the portable electro-magnet. The foreign body is withdrawn along the tract. Needless to say, fragments of magnetizable metal are the only ones that will respond. The use of too powerful a magnet, one that will make a piece of metal jump some distance, is most inadvisable. Deeply placed foreign bodies can frequently be extracted either with forceps or with the magnet. In my series they were removed in a little over half the cases. I had one unfortunate experience with magnet extraction. It was an instance of ventricular penetration by a large missile. The fragment was half way out of the tract when (because of its weight, or possibly because of poor contact) it dropped back. It was found in the ventricle only after considerable difficulty, and finally removed with forceps. The patient died about twelve hours after operation. French surgeons have employed extraction by means of the Hirtz localizing compass to which the extractor is attached. They also practised extraction under guidance of the fluoroscopic screen.

Both methods have given satisfactory results, but, unless practised with extreme care (which means that the extractor must remain in the tract), injury to the brain will be inflicted.

Control of Hemorrhage.—Hemorrhage at operation can usually be controlled without any great difficulty except when it arises from a distant region, such as the base of the skull; this, however, is an unusual occurrence. In order to prevent a post-operative collection of blood, that readily can become infected, it is essential that the field shall be dry at the end of the operation. The simplest way to avoid this is to establish hæmostasis step by step. Bleeding from the bone is usually trivial and ceases spontaneously. The application of Horsley's bone-wax ordinarily controls any excessive bleeding, but for large vessels in the bone wooden plugs or small pieces of muscle used as plugs may be required. Laceration of the middle meningeal artery is infrequent. Bleeding from small branches at the torn dural margin is frequently encountered. In either instance hæmostasis is established with fine silk ligatures or by using Cushing's silver clips.

Hemorrhage from torn venous sinuses does not offer great difficulties if the lesion is adequately exposed. The application of a fragment of muscle (or of aponeurosis if muscle is not accessible) is remarkably efficacious. The "postage-stamp" graft is held gently in place with the gloved finger for a minute or two, at the end of which time bleeding will have ceased. Large sinus tears may require suture with fine silk, or silver clips may be employed. On several occasions I have seen the longitudinal or lateral sinuses torn completely or almost completely across. In such instances I practised ligation of the divided ends. Muscle grafts might have established hæmostasis, but I felt that secondary hemorrhage might supervene if infection of the blood-clot occurred. Ligatures could not be securely thrown around the ends of the vessels, and I therefore employed the following technic: A short distance beyond the tear small nicks are made in the dura on either side of, and directly adjacent to, the sinus wall. The flat, blunt-pointed end of a probe with the eye carrying a silk ligature is bent to the desired shape (like a small aneurism needle) and gently passed beneath the vessel. Slight pressure on the needle when the membranous fold beneath the vessel is reached suffices to penetrate it. The triangular shape of the sinus in cross-section must be borne in mind, otherwise the vessel wall may be injured. The ligature should be tied only snugly enough to obliterate the lumen.

Bleeding from the lacerated brain requires little discussion. Ordinarily, it is well controlled by the application of moist or dry pledgets of cotton. Sometimes there is persistent oozing from one or two places, and bits of muscle should then be employed for hæmostasis. Bleeding cerebral vessels are ligated with fine silk. Torn cerebral vessels, thrombosed and not bleeding, are occasionally met at operation; if the divided ends are free, the vessels are tied and the excess portions ablated.

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Repair of Torn Dura—Suture. Transplantation of Fascia.—This aspect of the craniocerebral wound received scant attention. Surgeons were apparently satisfied with the removal of soiled and infective material and did not devote much consideration to the question of repair. Some sutured the smaller dural lacerations that could be closed, others left them open as a sort of safety-valve in the event of suppuration in the brain tract. The argument against closure of the dura was, of course, the danger of locking in an infection. But the whole plan of treatment as described is based upon the elimination of infective material, and its success is entirely centred thereon. Undoubtedly, suture of the dura would reduce the chances for recovery in some cases by closing off infective foci in brain tracts; however, the prognosis, whether immediate or ultimate, is always bad if such foci are left behind. A detailed consideration of the advantages of dural closure is included in the discussion on fascial transplantation. I believed that dural closure was a required step in the operation, and I therefore employed it as a routine procedure, omitting this step only in a small proportion of the cases under my care. These were wounds in the right temporal regions in which subtemporal decompression was done; wounds with purulent brain tracts; wounds in which the tear in the dura could not be adequately exposed; and finally, wounds in patients in too poor condition to devote the additional time for dural repair. Before dural suture is begun the devitalized margin is excised in the technic I have employed, as previously noted. By passing the interrupted sutures first at one and then at the other end of the tear, and thus working toward the middle, some lacerations apparently too large for suture can be closed.

In many cases, however, the loss of dural substance was too great for closure. For these I employed fascial transplantation. Without entering into details, I may say that fascia lata has been experimentally and clinically proved, by myself and others, to be an eminently satisfactory tissue for the replacement of visceral defects. Implanted into a dural gap, it becomes gradually replaced by a firm fibrous connective tissue almost indistinguishable from the dura, and lined by a layer of cells continuous with the dural endothelium. The reasons for suture of the smaller and fascial transplantations for the larger dural defects may now be enumerated: (1) To obviate infection from without, especially when bone sinuses have been laid open by the injury. (2) To minimize the chances for subdural infection in the event of post-operative infection or separation of the scalp. (3) To prevent leakage of cerebrospinal fluid in wounds with ventricular penetration. (4) To prevent adhesions between the lacerated brain and the scalp. (5) To afford a permanently firm physical protection for the brain surface. (6) To eliminate the possibility of injury to the brain at a subsequent reparative operation.

Before transplanting fascia the devitalized margin of the dura is excised. The technic of fascial transplantation is simple, consisting in

removing a portion of the fascia lata of the appropriate shape of, and slightly larger than, the dural gap, and fixing the transplant in place by four silk sutures. Interrupted stitches are placed between these, approximating edge of fascia to edge of dura. The transplants varied in size from 2 by 2 to 4 by 4 cm.

It is evident that fascial transplantation was employed only in serious cases, those in which there was much damage to the brain in keeping with the large dural tear. Of the 19 cases in which I used fascial transplants, 7 died. One of the deaths occurred four months later as the result of sepsis from a compound fracture of the leg. The autopsy showed the transplant well healed in place. The condition of the transplant is known in 4 of the surviving 12 cases, for they were subjected to reparative operations for skull defects. The transplant was described as satisfactory in all; in fact, in two instances operators were not aware that fascial transplantation had been done. Altogether, follow-up reports have been obtained in 9 cases, and in none were there symptoms that could be referable to the transplant acting as a foreign body. The first operation was done more than two years ago, and the last more than a year ago. Sufficient time has thus elapsed to be able to state definitely that the ultimate as well as the immediate results of fascial transplantation in cerebral wounds are satisfactory.

Indications for Drainage.—The sutured scalp incision is drained in one or several places if the head wound was definitely infected. If a brain tract is found to be purulent, or contains manifestly infected blood-clot, its drainage is indicated. Hemorrhage should be a rare indication for drainage. Altogether, drainage should be considered a very unusual feature after a properly conducted operation for a recent wound, for it defeats the purpose of the operation.

Closure of the scalp should and can be complete in the great majority of cases. The exceptional instances are infected wounds or multiple wounds with extensive loss of scalp. In suturing the scalp a separate layer of sutures is devoted to the aponeurosis. Better approximation is thereby obtained, additional support is given, hæmostasis is established, and the external sutures can be removed at an earlier time. With the tripod incisions that have been described closure was generally obtainable by sufficiently extensive mobilization of the flaps. Simple suture of the wound could be carried out in a large proportion (80 per cent.) of the cases in which the long elliptic incision I have described was used. In the remainder some type of plastic closure was required. The one I used most frequently was the S-shaped variety. The scalp is sutured from both ends as far as possible. Then, beginning at one end of the remaining defect, an incision is made through scalp and aponeurosis at right angles to the long axis of the defect. This incision is carried down a varying distance, depending on the required size of the flap, is then curved to run parallel to and for the full length of the defect, and is again turned down

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to run parallel to the first part of the incision. The resultant flap is now completely freed, slid over the defect, and sutured in place. The plastic incision can be closed completely in most instances by passing the sutures obliquely; a remaining defect at the furthestmost part of the incision, however, is of no moment. The success of the S-shaped plastic depends on its accurate placement, and, above all, on its length. The tendency is to make it too small, with an inadequate flap as a consequence. In a large defect over the forehead, for example, I have fashioned the plastic S-shaped incision so that its end reached beyond the occipital protuberance. Some of the defects of the scalp are of triangular or shield shape. Plastic closure of these consisted in prolonging the base of the defect on both sides to lengths sufficient to mobilize the two lateral flaps required for closure. There remained a small proportion of cases in which no typical plastic incision could be employed, and in these various incisions had to be devised to fit the particular case.

Had the war continued the entire question of closure of the scalp might have been put on a very different basis. Following débridement wounds in other parts of the body were either sutured primarily or subjected to delayed primary suture, depending on certain factors, such as the presence of streptococci in the wound. Similarly, delayed primary suture of the scalp in craniocerebral wounds might very well have been developed as a desirable refinement of technic.

Post-operative Course and Treatment.—In the lightly wounded the post-operative course is usually smooth; however, severe headache and dizziness are not unusual. In craniocerebral injuries, on the other hand, the course is often stormy even in those patients who are doing well. Rise of temperature may occur without any evidence of local or general infection. Restlessness is common, and, particularly at night, patients may become very violent, attempting to tear off dressings, get out of bed, and so on. This peculiar "dream state" may last a week or even longer, and yet be followed by complete recovery. It is not in itself of serious omen. Very frequently there is a complete amnesia for the events of the first two weeks after operation even in the lightly wounded. Indeed, many patients have written me that they remembered nothing or almost nothing of occurrences for a month or more after injury. And yet, not a few of these men seemed normal in every way at the time of leaving the hospital one to two weeks after operation. The treatment of some of these patients in the first days after operation, particularly as regards the mental state, the matter of feeding, and so on, is often very trying. The question of nursing is a most important element in the results that are obtained. Loud noises and clumsy handling have very disturbing effects on these patients. The administration of morphine not infrequently results in increased restlessness and violence. Chief reliance should be placed upon the bromides, used as a routine by some.

Aspirin and trional given together are often efficacious for headache. Rectal administration of bromides and of fluids, in patients who cannot or should not take anything by mouth, is very beneficial.

It is usually not difficult to recognize within a day or two after operation the cases that are not doing well. Coma persists, or those who have been alert complain of bursting headache and become stuporous. Signs of meningitis usually make an early appearance. In other instances the first evidence is found in an infection of the wound. Occasionally a series of severe convulsive seizures indicate the change in condition. However, surprises are frequent. One sees recovery in those whose outlook appears hopeless; and, unfortunately, some patients appear to be on the high road to recovery for even a week or more after operation, when a fatal infection supervenes.

In cases that recover the improvement in functional disturbances that often occurs within the first week or two of operation is remarkable. Without entering into details, it may be said that sensory disturbances, aphasias, and defects in visual fields frequently subside completely; the majority of paralyses and pareses (except the type due to brain destruction) begin to improve before patients leave the front area hospital. It is well to reiterate here that paralyses or other losses of function making their first appearance or increasing directly after operation are evidences of damage inflicted by the surgeon. In a considerable operative experience I have not seen such manifestations, and cannot, therefore, accept the theory advanced by some that they are due to cerebral oedema.

Even with rapid improvement in function or in the absence of functional loss patients should not be up and about for five weeks or more after operations for craniocerebral wounds. At best, headaches, blurred vision, pain in the wound, and giddiness on walking are common enough complaints in the earlier stages of convalescence.

In my experience very few complications developed after operation in recovering cases. In view of the grave significance of hernia cerebri I wish to emphasize the fact that I *saw but one instance* of this complication after operation in my series of cases. This was a much soiled penetrating wound in which infection developed at the suture line in the dura. The rarity of hernia cerebri after the complete early operation should be one of the strongest arguments for the adoption of that technic. Epileptic seizures are described as not uncommon after operation, and of lesser and different significance than the epilepsy appearing as a late complication. I have seen only two cases in which epileptic attacks developed shortly after operation; both patients have remained free from recurrence of attacks up to the present time. The great majority of the wounds should heal by primary union. In the small number of scalp infections I saw the majority were slight and readily controlled. Frequently repeated inspections of, and detailed care in, the treatment of the wounds are im-

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portant elements in successful results after operation. Later infections in the wound are of different significance, being referable to spicules of bone or other foreign matter that had been left behind.

Meningitis or cerebral suppuration after operation are fatal complications for which various therapeutic measures appeared to be of no avail.

Hernia cerebri as an early complication not infrequently recedes under proper treatment. Such procedures as enlargement of the bony opening for supposed strangulation of the brain or ablation of the fungus are mentioned only to be condemned. All the evidence points clearly to infection, and infection alone, as the cause of hernia cerebri. The hernia cerebri is generally the result of an incomplete operation. The hernia varies in appearance and size from a superficially infected, slightly bulging, small area of brain surface, to a large sloughing mass. By the use of the Carrel-Dakin treatment or perhaps, preferably, dichloramine-T in oil, progressive sterilization of the hernial surface can often be attained and, with it, recession of the protrusion. The use of gravity, by propping up the patient's head, is said to be of value. But the most useful therapeutic measure, in addition to attempts at sterilization of the wound, is repeated lumbar puncture. This procedure had many advocates who saw no evidence that infection may spread as the result of evacuating cerebrospinal fluid. The fluid should be withdrawn slowly, and not in large amounts at one sitting, otherwise the hernia may sink back through the cranial defect, and the infection certainly be diffused. The lumbar puncture should always be done with the wound exposed to view, so that changes in the hernia may be observed. In the later stages of hernia cerebri, as encountered in a base hospital, I have seen beneficial effects follow a subtemporal decompression.

Lumbar puncture is of value in the post-operative treatment of cranial wounds not only in hernia cerebri, but also for the relief of intractable headache or other evidences of cerebral oedema. I have, however, seen but few indications for its use in the recently wounded.

The *cause of death* after operations for craniocerebral wounds requires only brief comment. In the patients who die shortly after operation extensive brain destruction, sometimes due to ricochetting of the missile, is usually found. But autopsy shows infection to be the cause in the great majority of those who die at the front area hospital. In my series of cases suppuration was found not only in the brain and meninges, but also invariably in ventricles that had been penetrated by missiles or bone fragments. Not a few of these patients were operated upon twenty-four hours or more after injury, so that there appears to be a definite relationship between fatal infections and the time after wounding at which operation is performed. It is difficult to make a more definite statement because the time at which the wound was sustained could not be determined in many of the serious cases.

Results of Operation for Recent Craniocerebral Wounds.—Little information can be derived from the voluminous literature on head wounds concerning other than the immediate or intermediate results of operation. Careful studies have been made of results noted after head wounds, but these have not been linked up with various operative measures that were employed, or with the lesions encountered at operation. Since this paper is, after all, an essential commentary on the operative technic of craniocerebral wounds, I will detail the results of operation in my series of cases as based on follow-up reports. The latter have been received from the patients themselves, as well as from those under whose care patients subsequently came.

Before discussing the late functional results and complications the *mortality after operation* in these cases should be taken up. In general, the mortality from head wounds with intact dura is small with any technic that includes removal of the soiled wound and bone fragments. Occasionally, however, infection passes through an intact or bruised dura with fatal issue, so that here, too, the elimination of infective material by a properly conducted débridement is an important element in success. Among my cases death after wounds of the head with intact dura came as a result of other wounds. The usual mortality after operation for head wounds with dural penetration ranged from 50 to 60 per cent. in the different reports. In Cushing's report the significant feature was that his mortality in a first series of cases done in the older way was 54.5 per cent., and in a third series, with the improved operative technic, it was reduced to 28.8 per cent. His publication appeared too soon after the operations were performed to include possible subsequent deaths, so that the figures must be accepted for the mortality in the early weeks after operation. An important point is that deaths from any cause were included, even if unrelated to the head wound. This is the only basis upon which the mortality rates should be given, for there will be no general agreement on conditions that may be justifiably excluded. By paring and pruning, even with the utmost honesty, attractive figures can be produced that will in no way represent the gravity of craniocerebral wounds.

The cases that were under my care fall into two series, the first (95 cases) operated upon in 1917, and the second (80 cases) in 1918. The great majority of deaths occurred in the first weeks, and not a few (certainly 5 per cent.) from other lesions. A number of the later deaths were definitely unrelated to the head wounds, as in a case in which death resulted from sepsis from a compound fracture, and post-mortem examination of the brain showed no evidence of infection. The mortality from every cause is, however, included in the following tabulation. It is based on reports received from time to time until January, 1920, and thus represents the mortality up to the present time. Follow-up reports were obtained in four-fifths of the cases of dural penetration.

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	Percentage mortality first series, 95 cases.	Percentage mortality second series, 80 cases.
I. Scalp wounds	0	No cases
II. Cranial wounds—dura intact	8.5	6.2
(a) Simple fracture	6.6	No cases
(b) Depressed fracture	0	5
(c) Bursting fracture	100 (1 case)	25
III. Craniocerebral wounds—dura torn	42.5	29.4
(a) Depressed fracture	16.6	0
(b) Tangential wound	33.3	16
1. Ventricle intact	12.5	10
2. Ventricle penetrated by bone fragments ..	75	33.3
(c) Penetrating (metal retained)	30	34.3
1. Ventricle intact	25	20
2. Ventricle penetrated by missile	100	85.7
(d) Perforating	100	66.6

In the first series the technic of operation as described had not as yet been fully developed; the figures are sufficient commentary upon the difference in the results obtained. The results can be better interpreted if I add that a selection of cases was made possible when the second series were operated upon, and that only cases evidently or probably severe were chosen. This is seen in an analysis of the lesions in the 13 patients in the second series who died at the front area hospital: Ventricle penetrated by missile, 6 cases; perforating wound, 2 cases; multiple brain penetrations by missiles, 2 cases; penetration from vertex to base, 1 case; penetration complicated by gas infection of the brain, 2 cases.

The *late results* in the patients who recovered may now be discussed. The most impressive feature of the follow-up in both series of cases is that there is not a single report of late hernia cerebri, meningitis, or brain abscess. Since the great majority of these later complications are known to develop in the first six or nine months, it is reasonable to assume that they will certainly be at least very infrequent at this late date. Next in interest were the changes that occurred in paralyses and pareses. The improvement that took place in the first weeks after operation has already been noted. Reports received from time to time show that this was continuous in a large proportion of the cases. So that at the present time the course of paralyses and pareses can be termed one ranging from progressive improvement to complete disappearance in the majority of cases. Spasticity and persistent paralysis were each reported twice. There was one case of persistent aphasia and two of permanent deficiencies in the visual fields. Epilepsy is considered the most common tardy manifestation after head wounds, yet up to the present there have been only three statements of its appearance. Two of the patients have petit mal and in neither was there a dural penetration; the third, suffering from generalized seizures, had a penetrating wound from which the foreign body was not recovered. The reports in two cases suggest that insanity may have developed; the

dura had been penetrated and the foreign body retained in one, and the lesion was a slightly depressed fracture with intact dura in the other. Persistent headaches and dizziness of varying degrees were reported by fully 20 per cent. of the patients. Other subjective symptoms, such as insomnia, hypersusceptibility to sounds, inability to concentrate, and so on, were also frequently mentioned, but these, like headache and dizziness, bear no proportionate relation to the gravity of the wound. Some of the patients have returned to former or other occupations, some are engaged in study, and only a small proportion (6 per cent.) appear to be permanently incapacitated as the result of head wounds. The conclusion that should be drawn from these follow-up reports is that the ultimate prognosis for patients with craniocerebral wounds after radical early operations is far more optimistic and cheering than seems generally thought to be the case.

The Treatment of Infected Craniocerebral Wounds.—The indications for, and the methods of treatment of, this class of cases are totally different from those for recent wounds. As already noted, the attempt to care for infected wounds in a similar manner led to disastrous consequences. Within twenty-four hours of the time of injury the wound may be definitely infected; wounds not operated on are almost certain to be infected by the time patients reach base hospitals. The indications for operation then vary within wide limits and no definite rules can be laid down. The neurologic manifestations and particularly the condition of the eye-grounds are often the decisive factors. Hernia cerebri or other infected lesions can often be successfully treated by the Carrel-Dakin or other non-operative methods for wound sterilization. If operation is decided on, it should be sharply limited to the area of infection, and equally limited to steps for the control of infection. Spreading infection and death may otherwise be the sequel. Loose bone fragments, bits of cloth, or other foreign material may have to be removed, and a purulent brain tract drained.

At best, the results were unsatisfactory in the cases I saw, whether or not secondary operations were performed. Neurologic manifestations and infection showed a tendency to persist and even to progress. The results were, of course, worse with dural penetration. If a hernia cerebri made its appearance the ultimate prognosis became bad, in my experience. Although the hernia may have receded with persistent efforts at wound sterilization, I found, by following the course of these cases, that the hernia often meant either early acute infection of the brain or the focus in the brain for the later development of a brain abscess.

Late Complications and Sequels of Wounds of the Head and Their Treatment.—Final statements upon this very important aspect of the subject of head wounds cannot be made at the present time. Tuffier and Guillain¹⁰ and Sargent and Holmes⁹ have made studies of large groups

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of cases, analyzing the results without direct reference to the types of operative technic that had been employed.

Subjective symptoms, such as those already noted, are without gravity as far as life is concerned, but of great importance from the social viewpoint. I have stated that they bear no relation to the gravity of the wound, yet that does not indicate the significance of subjective symptoms. The size of the cranial defect is not a factor, for they are as common in small as in large breaches in the skull. Possibly a form of malingering in some cases, they appear in others to have a definitely organic origin as established by examination of the eye-grounds and the cerebrospinal fluid. Lumbar punctures often seem to have a favorable effect on subjective manifestations, especially on headache and vertigo. Subjective symptoms in themselves should never be the sole indication for a secondary operation such as cranioplasty or removal of a foreign body.

Organic Manifestations.—Destructive cerebral lesions produce results that, of course, vary widely, depending on their seat and extent. Details cannot here be given. The outcome of lesions of the frontal lobe appears to be favorable, even with large losses of substance; many of the patients suffer no mental disturbance. The improvement that often occurs after lesions in the sensorimotor cortex has already been described. Involvement of the pyramidal tracts usually results in permanent spastic paralyses. The prognosis of persistent aphasia is bad; although some improve, the great majority remain intellectually subnormal. Visual defects from lesions of the occipital lobe have a relatively favorable prognosis, the early symptoms showing a tendency to recede and the residual disturbances often were slight.

Serious mental disturbances are exceptional, and in some cases precise information concerning the antecedent history would have been necessary to establish the causal relationship between the wound and the psychosis. Insanity occurred in 0.64 per cent. of the 6664 cases in the statistics of Tuffier and Guillain.

Epileptic attacks comprise the most common late complication, occurring in over 10 per cent. of the cases in Tuffier and Guillain's series. They may make their first appearance anywhere from a few months to two years after the injury, and even more delayed first appearances may be recorded in the future. Generalized seizures are more common than petit mal. Epilepsy has followed wounds in which the dura and even the skull were intact, as well as wounds with proved cerebral injury. Although lesions in the Rolandic area may be followed by epilepsy of the Jacksonian type, injury of the motor cortex as well as of other parts of the brain may result in generalized, non-focal seizures. The latter are, of course, of no aid in localizing the lesion. Occasionally epileptic attacks may be the first manifestation of an acute encephalitis or brain abscess.

Operation is not indicated in generalized epilepsy for the following reasons: There is no indication as to the region of the brain to be

explored. The dura should not be opened at the site of the wound merely to divide adhesions that will almost certainly reform; besides, such adhesions are commonly met in old brain wounds in patients who are not suffering from epilepsy. If the purpose of the operation is to reduce tension, other means, such as lumbar puncture or a subtemporal decompression, are more desirable. Repeated lumbar punctures appear to have a favorable effect on the number of attacks. An exploratory operation on the cicatrix is perhaps permissible if the attacks progressively increase in frequency and appear to be leading to permanent mental inferiority.

Jacksonian seizures offer a more favorable indication for operation. A few isolated focal attacks should not, however, lead to operative intervention, for they may be the result of an encephalitis that may clear up, or, in any event, cannot be relieved by operation. The presence of sequestra or a missile in the region of the motor cortex is the chief reason for operation in repeated Jacksonian seizures, and their removal may be followed by prolonged relief.

Late brain abscess occurred in a little over 1 per cent. of the cases, and is thus happily much rarer than would have been supposed. This grave complication is most commonly seen after wounds in which brain substance was exposed and in wounds that have suppurated. A tear in the dura had existed in almost all the reported cases. Too great emphasis cannot be placed on the evidence that the missile itself is not the principal cause of brain abscess; infection from sequestra, bits of cloth or other foreign material swept into the brain is the common etiology. In fact, abscesses about missiles are met in only a small proportion of the cases. The abscess is found at the site of the wound in the majority of cases, either in an existing hernia or in brain substance that has herniated. Abscesses in regions far removed from brain tracts are occasionally found. In 37 cases studied by Sargent and Holmes the overwhelming frequency of brain abscesses in the first three to six months after injury is shown; 28 patients developed abscesses in that period, whereas the complication appeared in the six to nine months' interval in 7 cases. The latest appearance of brain abscess was in the eighteenth month.

In some cases of brain abscess there are no indications of its development, and in others the course is an acute fulminating one, but in the great proportion of instances the usual symptoms and signs of brain abscess are gradually unfolded. An important point is that papilloedema is frequently absent. It is often difficult to make the differentiation between abscess and encephalitis. The value of regularly repeated careful neurologic examinations in patients with old craniocerebral wounds will be appreciated when one realizes that the reappearance of or increase in an old mono- or hemiplegia that was improving, or increase of an aphasia, may be indications of the development of a brain abscess or important localizing signs of the seat of the abscess.

Brain abscess unrelieved by operation is fatal; yet the vast majority

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of patients (97.5 per cent. in Sargent and Holmes' series) die after drainage of pus. The least complicated procedures should be employed. The removal of a projectile or of sequestra in the abscess cavity is indicated, but the extent of dissection should be minimal under any circumstances if spreading infection is to be avoided. Subdural adhesions should not be disturbed. There may be a varying period of improvement following drainage of a brain abscess, but ventricular infection or further spread into the adjacent brain tissue with fatal issue are the common sequels. In my personal experience drainage of the abscess cavity has invariably been followed by death. On the other hand, there was one instance in which the patient has apparently remained free from recurrence for more than a year following *aspiration* of a deep-seated abscess. Such a procedure for brain abscess appears illogic at first sight, but several factors should be considered. The infecting organisms must be of low virulence in many cases. By aspiration of the pus collapse of the walls of the cavity is invited, or in rigid walled cavities a fresh exudation of bactericidal fluids. Drainage of a brain abscess frequently lights up the infection as a result of fresh paths that are laid open, and this appears to be almost inevitably the result, no matter what form of drainage is employed. Theoretically, then, superficially situated brain abscesses might better lend themselves to drainage; deep-seated abscesses, to aspiration. The abscess having been located, aspiration can be repeatedly performed if necessary. If drainage is to be employed, I believe a two-stage operation might be followed by less disastrous results. The first stage would consist in locating the abscess by aspiration, dissecting a tract to its site, and inserting a tube. Several days later the abscess would be entered and the drainage-tube inserted into the cavity.

Hernia cerebri is due to infection and generally masks an abscess or an area of encephalitis. Violent headache, high temperatures, torpor, and occasionally epileptic seizures precede its appearance. *Lumbar puncture should not be employed* in the acute phase, for it may be followed by spread of the infection. In the relatively favorable instances in which an encephalitis is the cause the protrusion may begin to recede in two or three weeks with one of the methods of wound sterilization; lumbar puncture aids in the reduction of the hernia under such circumstances. When an underlying brain abscess is the cause, this must, of course, be cared for. Excision or compression of the hernia or enlargement of the bony opening should be condemned. It may be necessary, however, to remove necrotic brain substance. In some cases of persistent hernia with a low-grade infection contralateral decompression has been done with favorable results; I have seen one case in which striking improvement followed.

Late meningitis is the most fatal of the tardy complications after craniocerebral wounds, but is fortunately rare (0.48 per cent.). As a sequel to brain abscess it has already been noted. Meningitis may also result from fistulae arising from necrotic bone or infected foreign material. In its localized form the condition exists as an encystic meningitis, and

is characterized by cortical irritation and the signs of increased intracranial tension. Operation, consisting in drainage of meningeal collections of pus and the elimination of the foreign material, is occasionally successful. The generalized type of meningitis is exceedingly fatal, although occasional cures have been reported following frequent large lumbar punctures.

Encephalitis is a condition difficult to differentiate from brain abscess. It can sometimes be recognized when local cerebral symptoms arise from time to time, to recede spontaneously. In general, the symptoms are not as severe as in brain abscess. They are known to have receded after removal of bone fragments or other foreign material, but have also cleared up after negative exploratory operations. If encephalitis can be diagnosed, operation is not indicated.

Retained missiles in the brain do not in themselves comprise a late complication of head wounds, for a considerable proportion of the patients are free from symptoms. The question arises as to whether foreign bodies should be systematically removed in all cases. This is answered in the affirmative by those who hold that the foreign bodies are only apparently well tolerated, and that the patients are exposed to the possibilities of grave complications, such as brain abscess, or to sudden death. But Pierre Marie, for example, has had under observation more than 80 cases of retained intracerebral projectiles in which there were absolutely no symptoms or signs referable to the foreign bodies. All the evidence at hand at the present time indicates that foreign bodies can be perfectly tolerated. Under such circumstances there should be no routine removal of retained missiles. The operation is not free from danger, and may result in the aggravation of existing disturbances in function, or the development of new neurologic manifestations. A destructive lesion of the brain having been established, removal of the foreign body will not improve it.

Headache, vertigo, and other subjective symptoms are not indications for the removal of the foreign body. It should be removed if it is the probable cause of attacks of encephalitis or of a brain abscess. Lymphocytosis in the cerebrospinal fluid, associated with signs of increased intracranial tension, suggest the desirability of operation. The method of choice for the removal of foreign bodies is an approach through the cicatricial tissue occupying the former tract, and extraction with the electromagnet.

Cranial Defects and Their Repair.—Many papers have been written on the indications for cranioplasty, and more on the technic to be employed. The confusion that exists on this subject will not be cleared up until the sequelæ with and without operation are better known than at the present time. Such symptoms as headache, vertigo, and even epileptic attacks are considered indications for cranioplasty by some, and these very symptoms are contraindications to operation for others. In a study of a number of cases operated on Marie found improvement in subjective

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symptoms in some, no relief in a larger number, and aggravation of the manifestations in others. Even new symptoms are reported to have developed after operation. Under such circumstances a clear therapeutic indication for cranioplasty cannot be said to exist at the present time.

Cranioplasty may, however, be indicated for protection of the brain and for esthetic reasons; the latter is particularly true for large skull defects in the frontal region. An operation should not be performed until the wound has been healed for several months. Any symptoms that indicate the possibility of a late complication are contraindications; if such manifestations have already appeared, the operation is not justified, even though they are, for the time being, in the background. The cerebrospinal fluid and eye-grounds should show no evidence of increased intracranial tension.

Many types of operation have been performed for the repair of cranial defects, and good results have been reported after all of them. A description of the various operative procedures cannot be here given. They may be classified as follows:

- a. Cranioplasty, which is, strictly speaking, a procedure consisting in plastic flaps fashioned from the skull itself.
- b. Bone grafts, auto-, homo-, or heteroplastic, with or without periosteum.
- c. Grafts of decalcified or macerated bone.
- d. Cartilage grafts.
- e. Osteocartilaginous grafts.
- f. Prostheses of gold, platinum, silver, or ivory.

Cranioplasty, either of the Mueller-Koenig variety or one of its modifications, is only suitable for the smaller defects. It cannot be employed in the frontal region because of the additional scarring that results. Autoplastic bone and cartilage grafts are most widely used; excellent results have been described after both. Villandre, who has had a large experience, reports 100 per cent. success with osteoperiosteal grafts taken from the tibia, and 96.8 per cent. with rib-cartilage transplants. It is as yet too soon to make any definite statements concerning the ultimate fate of such autotransplants.

Application of the Experiences in Craniocerebral War Wounds to Head Injuries and Other Intracranial Lesions in Civil Life.—Cranial injuries with extrusion of brain substance are rarely seen in civil practice, but depressed fractures with or without dural puncture and brain damage are not at all uncommon. A soiled scalp wound is often present in such deeper injuries. It is for these cases that the operative technic as described for gunshot wounds has its main indication in head wounds in civil life. The operation heretofore practised has generally consisted in incision, piecemeal removal of depressed fragments of bone, removal of spicules from the brain, and institution of drainage. The results have, on the whole, been unsatisfactory. I have recently seen two cases in which brain abscess followed such operations. There is every reason to believe

that a great stride forward will be made in the treatment of soiled cranio-cerebral wounds of civil life when the technic developed for gunshot wounds shall have been applied with the same meticulous attention to details. On the other hand, it would manifestly be a grave mistake to consider cerebral penetrations by small-calibred, relatively low explosive bullets of civil life in the same category with the injuries caused by war projectiles. In the former case relatively little foreign material is swept into the brain by the missile, the wound of the scalp is generally a non-soiled, punctured lesion, and thus the indications for a débridement of the tract do not exist in the vast majority of instances. Our knowledge as to the surgical treatment of complications encountered at operation has also been enhanced, and this has its direct application not only in traumatic surgery, but also in cranial operations for other conditions. The more logical methods of treatment of late complications of head wounds (epilepsy, hernia cerebri, etc.), evolved during the war, should improve the procedures employed in similar lesions encountered in civil practice. Indications for and methods of repair of dural defects were developed; they will probably have a wider application in cranial operations for other conditions than fractures. The indications for extraction of intracerebral projectiles and for repair of cranial defects have been more clearly defined, and the technic of operation greatly developed. Finally, the many advantages in conducting cranial operations under local anæsthesia, demonstrated during the war, will undoubtedly be recognized as existing to a similar extent in cranial operations in civil life, and thus another lasting addition to the technic will have been made.

BIBLIOGRAPHY

The voluminous literature is largely reviewed in the following two volumes: War Surgery of the Nervous System. A Digest of the Important Medical Journals and Books Published During the European War, 1917. Office of the Surgeon General, Washington, D. C.

Velter: Plaies Pénétrantes du Crâne par Projectiles de Guerre, 1917, A. Maloine et Fils, Paris.

Other references are:

Cushing: Brit. Med. Jour., Feb. 23, 1918.

Cushing: Brit. Jour. Surg., 1918, vol. v.

De Martel: Trait. Opérat. Plaies du Crâne, 2d ed., 1918, Masson and Company, Paris.

Eisendrath: War Injuries of the Skull. A Collective Review, Surg., Gyn., and Obst., 1917, vol. xxv.

Leclerc and Walch: Cranial Grafts, Bull. et Mém. Soc. Chir., Paris, 1196, vol. xlii.

Lemaître: Lyon Chirurg., 1918, vol. xv, p. 65.

Sargent and Holmes: Injuries of Scalp, Longitudinal Sinus, Jour. R. A. M. C., 1918, xxv, p. 56.

Sargent and Holmes: Later Results of Gunshot Wounds of the Head, Jour. R. A. M. C., 1916, xxvii, p. 300.

Tuffier and Guillaumin: Comp. Rend. Confér. Chir. Interalliée p. l'Étude d. Plaies de Guerre, Paris, 1918, p. 263.

A NEW APPLIANCE TO SECURE PROPER POSITION AND STEADINESS OF THE HEAD DURING BRAIN OPERATIONS

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MANY appliances have been designed by surgeons and instrument makers to secure the combination of satisfactory position and firm retention of the head during operations upon the skull and brain. Some of these appliances have decided advantages, each of them has some disadvantages. A combination which will allow satisfactory exposure of the cerebrum may totally fail in permitting satisfactory exposure of the cerebellum.

The purpose of the table described in this article is to permit the placing and holding of the head in a position suitable for operation upon the cerebrum or the cerebellum. The position is attained by easily-effected adjustments.

The table used is the standard operating table with an angle-iron support at the head of the top of the table. On each side are two yokes bolted to the angle iron beneath the glass top. In the centre of the yoke a square rider 12 inches in length and $\frac{3}{4}$ inch in breadth is placed and holes are bored through it at intervals of $\frac{3}{4}$ inch. To hold the rider at the level desired, a set-screw is passed through it and into the yoke at the other side where it meets a threaded socket. These side pieces enable us to obtain a desirable height to fit the physique of the patient, and they also allow of the raising or lowering of the shoulders as the surgeon may desire.

The accurate adjustment of the appliance to the breadth of the shoulders of either an adult or a child is accomplished by an expanded portion with a tunnel at the top of the head. This is $\frac{3}{4}$ inch square. Through it the threaded pieces move laterally or medially as desired. A thumb-screw holds the sliding shoulder pieces. A flared-out shoulder rest 4 inches long and padded with gauze accommodates each shoulder.

By raising or lowering the side pieces and sliding the shoulder supports in and out, the height from the table and the breadth of the shoulders can be adjusted and the instrument can be held in place by two thumb-screws, one through the rider and yoke for elevation, the other in the top of the rider through the sliding shoulder rest. As the pieces are square, composed of $\frac{3}{4}$ -inch steel and held by the threaded thumb-screws, there is no danger of twisting, dropping or unsteadiness of the apparatus when in use.

The head rest is, of course, the more important consideration. The

standard operating table has a glass plate on either side with a space of 2 inches between the plates. Two rolled-steel rods, each $\frac{3}{8}$ of an inch in diameter, threaded at each end and bolted, are fastened to the angle iron beneath the glass plates. On these is placed a saddle bored out to accommodate each rod, the saddle being so designed as to ride back and forth on the rods. On each side of the saddle a thumb-screw is used to fix it in place when the proper position has been ascertained. These screws come flush against the rods.

To obtain the desired height for the head, a hole is made in the centre of the saddle $\frac{3}{4}$ inch square and through this hole the centre rod of the head support can be raised or lowered and the proper height is set, the thumb-screw beneath the side is tightened. We gauge the distance for long necks and short necks by simply moving the saddle along the rods and setting the screws. The proper distance is quickly found and is certainly maintained.

By means of this simple mechanical device set on a standard table a steady head and shoulder rest is readily obtainable and the surgeon can have a patient upon the face or upon the back as desired. We have found that when a patient is on his back, by simply raising the riders of the shoulder pieces and lowering the head piece an excellent position is obtained for surgical work on the face and on the neck.

The appliances in ordinary use not unusually are out of order when wanted, are hard to adjust, or fail to give exactly the proper position, or lack steadiness.

This instrument can be applied to the operating table in a few minutes. It can be removed by simply loosening the two thumb-screws in the two rods and the three in the saddle and slipping out the pieces, and the table is again the ordinary table for everyday surgical procedures.

The cuts indicate the simplicity and arrangement of the apparatus.

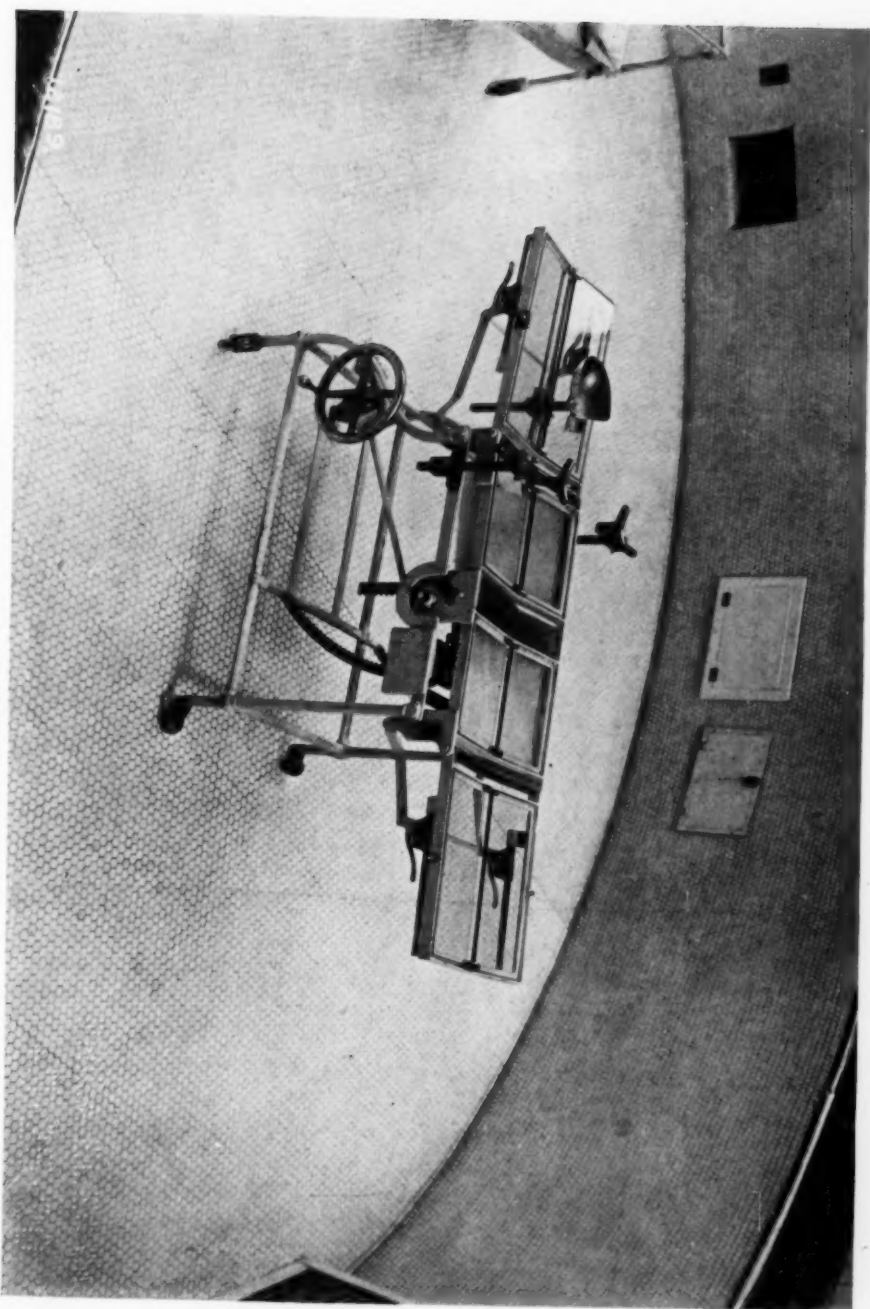


FIG. 1.—Apparatus adjusted to standard operating table.

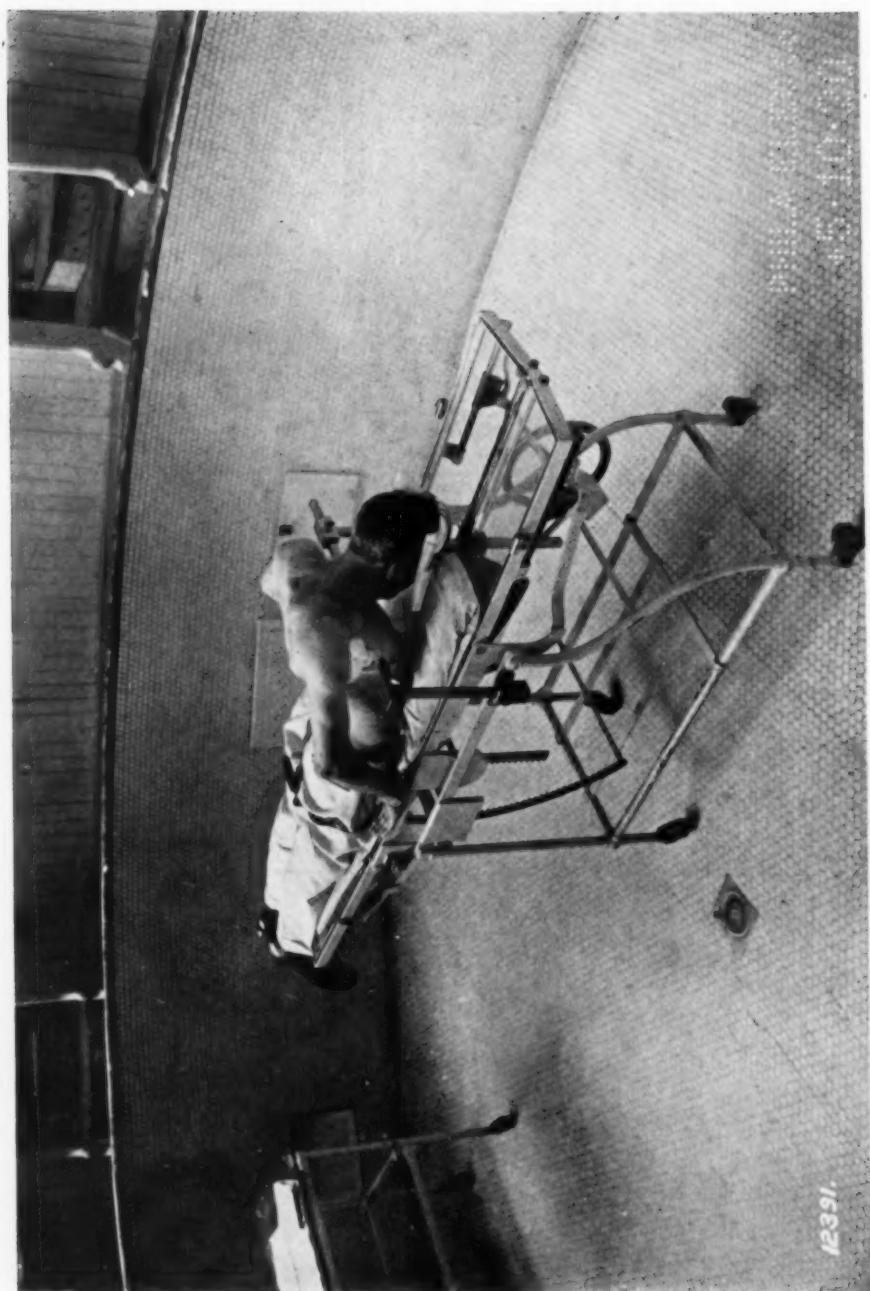


FIG. 2.—Patient posed for exposure of cerebellum.

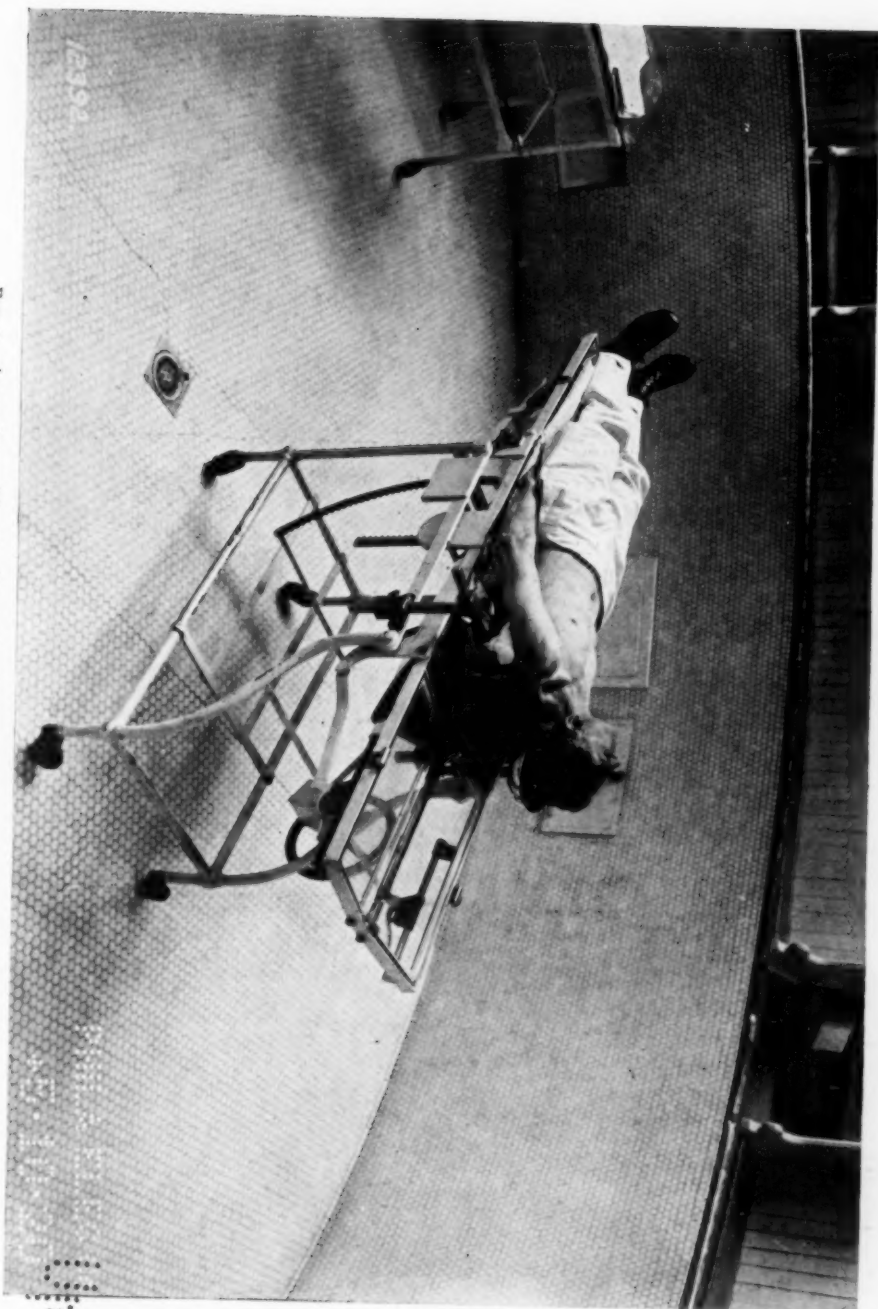


FIG. 3.—Apparatus used for securing position for operations on neck and parts of head.

PERFORATING GASTRIC AND DUODENAL ULCER *

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OF THE acute abdominal crises perforation of a gastric or duodenal ulcer ranks easily first in its dramatic suddenness of onset, its violence of symptomatology, and its gravity.

During the past six years I have operated upon twenty-four of these acute perforations with three deaths, a mortality of $12\frac{1}{2}$ per cent. Contrary to the usual statistics, a large majority of my cases have been gastric rather than duodenal, but with one exception, all were within 3 inches of the pyloric ring.

The duration of acute symptoms has been within the twenty-four-hour period in all but two cases, both of which died, and many cases were within twelve hours. The peritonitis was localized to the site of perforation in all except the two fatal cases mentioned. The ulcer base varied in size from 2 to 8 cm. and the perforation from 3 to 8 mm. Closure was easily effected in all save two, to be described later in this article. In-folding mattress sutures of fine chromic gut, in two layers, widely placed, were used exclusively. Posterior gastro-enterostomy was done but once, the details of which will be given later.

No "toilet" of the peritoneum was carried out and no drainage used for the uncomplicated cases. The appendix was found markedly involved in all cases and removed except in the three fatal cases and one other very poor risk. One case had a coincident acute cholecystitis and appendicitis. The appendix was removed and the gall-bladder drained. Two cases with coincident cholecystitis and cholelithiasis were treated by partial cholecystectomy and drainage.

Recovery in all but the fatal cases was remarkably smooth and uncomplicated except for a few mild superficial infections.

The end-results in the twenty-one recovered cases are known in about one-half the cases. Two came to gastro-enterostomy for pyloric stenosis. Of these one had had a previous perforation sutured in another clinic. Both were completely relieved. All the remaining cases seemed entirely free from ulcer symptoms and were in excellent general health when last examined.

The diagnosis in all the uncomplicated cases was obvious on the most cursory examination. The exceptions are as follows:

CASE I.—A man, aged about forty years, with a history of lues and definite signs of tabes. He had had repeated gastric crises. For

* Read before the Clinical Society of Montclair, June 7, 1920.

about twenty hours he had had severe epigastric pain. Tenderness and rigidity were moderate. There was a slight rise in temperature and in the leucocytes. Operation revealed a small ulcer near the pylorus with perforation a few mm. in diameter. Recovery was uneventful.

CASE II.—Colored female. She was in very poor general health, had signs of tuberculosis of the lungs and rather marked hyperthyroidism. An ulcer of the lesser curvature had been discovered by X-ray and was being treated medically, but she became unmanageable and left the hospital. In a few hours she returned with severe pains and signs of perforation. She was quite hysterical and persisted in sitting upright. Nothing could persuade her to lie down. Operation disclosed an ulcer on the posterior surface of the stomach near the lesser curvature and an acute cholecystitis with cholelithiasis. The ulcer was œdematous and bled freely, but had not completely perforated. It was infolded with great difficulty, the gall-bladder removed nearly entirely, and drainage inserted. Recovery was quite stormy and protracted.

CASE III.—Male, white, aged about forty years. Attack began six hours previously and was typical in all symptoms except that as in Case II the patient persisted in sitting upright and could not be induced to lie down for more than a few seconds. Operation revealed a perforated ulcer near the pylorus and an acute cholecystitis. The gall-bladder was removed, drains were inserted, and recovery was uneventful.

CASE IV.—Male, white, aged about forty years. The history and signs in this case were typical except that the temperature and tenderness were excessive and the leucocytes were high. Operation revealed an acute cholecystitis and cholelithiasis with perforation into the duodenum. Possibly this case should not be included in an ulcer series, but an acute perforation of the duodenum certainly had occurred. A partial cholecystectomy was performed, drainage instituted, and no attempt made to close the perforation. Recovery was delayed and rather troublesome, but finally was complete.

CASE V.—Male, white, aged forty-five years. Had definite ulcer symptoms and had been given a positive diagnosis of duodenal ulcer five years before the acute onset. He was a Christian Scientist, however, and refused treatment. At the end of this time a severe hemorrhage brought him to terms and he began medical treatment. During a month he gained 8 pounds and seemed on the way to recovery when he had a sudden onset of violent pain with slight rise in temperature, pulse, and leucocytes. At operation a very large ulcer involving the pylorus, duodenum, and stomach was found, with perforation into the pancreas from the duodenal side. No safe operative approach was possible and a posterior gastro-enterostomy was done to relieve the stenosis. A drain was inserted. He made a fair rally for twelve hours, but succumbed at the end of thirty-six hours from asthenia. Post-mortem examination showed no extension of the peritonitis and no especial reason for the fatal outcome.

PERFORATING GASTRIC AND DUODENAL ULCER

In another similar case I would be tempted to do a simple jejunostomy rather than a gastro-enterostomy. I did not realize his weakened general condition. Of the two other fatal cases, one was in a very stout alcoholic with advanced cirrhosis of the liver and a perforation of several days' standing, with generalized peritonitis. The ulcer was very large and appeared possibly malignant. Death occurred about twenty-four hours after operation. No post-mortem was permitted. The third fatal case was in a feeble subject also, with cirrhosis of the liver. Perforation had occurred two days previously and there was a marked spreading peritonitis. No drainage was used. The wound was opened the following day and drains inserted, but death occurred from exhaustion on the following day. All the cases showed a free perforation except three, two of which have been previously described. The third showed a perforation covered by the liver and partially sealed.

The diagnosis of acute perforation of the stomach or duodenum is remarkably easy except in the complicated cases. On the other hand, acute perforations of the gall-bladder from gangrene, acute pancreatitis, and occasionally high-lying perforated appendices will give symptoms suggestive of stomach perforation. In no case that I have seen, however, has there been any such onset of agonizing pain, nor such board-like rigidity in the first few hours. After twenty-four hours, of course, the symptoms are masked by the spreading peritonitis.

Shock has never appeared to me to be present in any of the cases. Vomiting is not the rule, either.

One case of error in diagnosis caused me great chagrin. A soldier was suddenly taken violently ill at midnight with intense epigastric pain. Examination showed extreme rigidity of the abdomen, and the previous history of loss of weight and vomiting of blood with "dyspepsia" seemed to clinch the diagnosis. The ward surgeon was summoned and, much to my disgust, was able to demonstrate the symptoms were all assumed and that the real diagnosis was a very mild attack of "flu." To the best of my recollection this is the only non-surgical case I have seen at all simulating an acute perforation.

That perforations do occur which become quickly adherent and closed is undoubtedly true. I have seen a few that might possibly have been such, besides one that had gone on to a local abscess formation. Many times adherent scars suggestive of old healed perforations are found at operation or post-mortem. The great majority of acute perforations, however, go on to spreading peritonitis and death if not closed surgically.

The treatment of acute perforations is obvious and, moreover, is easily carried out in nearly all cases. A simple high laparotomy and suture of the opening can be done in a very few minutes. The only question of other procedure is whether a gastro-enterostomy should be added. Deaver urges that this be done in all cases. Conners is just as strongly opposed. Many surgeons, like Peck, take a middle ground, doing the gastro-enterostomy in cases seen early and without peritonitis.

The argument for gastro-enterostomy, of course, is that it tends to aid in the healing of the ulcer and to obviate a later operation for resulting stenosis. On the other hand, it is well known that by far the greater number of all perforating ulcers tend to heal promptly after closure and that reperforation, hemorrhage, and stenosis are exceptional sequelæ. Moreover, it is difficult, if not impossible, to tell at the time of operation whether or not stenosis will occur. The mere fact that it is present after the suturing has been done is not conclusive, as it is very improbable that such stenosis will persist. When one considers how difficult, if not impossible, surgeons have found the operation of pyloric occlusion, surely it can hardly be thought a few fine chromic sutures will bring about this end.

To my mind, however, the strongest arguments against the added operation are twofold. First, the added immediate mortality will be considerable. Even in the hands of such masters of surgical technic as Peck, Deaver, and the Mayos, there is a certain, although low, mortality for gastro-enterostomy, even in non-acute cases. Second, the end-results of gastro-enterostomy, even in the best clinics, are not 100 per cent. good. When one considers that by far the great majority of these acute perforations will always be operated upon by surgeons of much less skill and experience, especially in gastric surgery, it would seem only the part of wisdom to do the simple life-saving operation and await the result, with a later gastro-enterostomy for the small percentage of those requiring it. I feel sure that I voice the feelings of most conservative medical men, including surgeons, in saying that I would not care to have a gastro-enterostomy done on myself if it could be avoided.

The cause of gastric ulcer is yet unknown, but the occurrence of chronic appendicitis in such a large proportion of the cases is suggestive of one etiological factor. Other chronic infections probably have a similar relationship.

In my cases it was usually difficult or impossible to obtain any history of chronic gastric disturbance before operation, but afterward when the severe mental and physical distress were abated, close questioning usually elicited a fairly typical ulcer history.

In conclusion, twenty-four cases of acute perforation resulted in eventual cure in twenty-one patients. One of the fatal cases was hopeless at the time of operation and the other two were in very grave condition.

Early diagnosis and simple closure of the perforation will result in cure in a very large proportion of cases. Gastro-enterostomy should be reserved for the few who may need it later.

I wish to express my most sincere thanks to Doctors Charles L. Gibson, Alfred Taylor, and William Lockett, in whose service these cases, with two exceptions, occurred, and to whom I am deeply indebted for the privilege of publishing them.

NOTE.—Since this paper was read one more case has been operated upon by me in the service of Professor Gibson, the Cornell Division of the New York Hospital. Recovery ensued after a very stormy convalescence.

PERSISTENCE OF PYLORIC AND DUODENAL ULCERS, FOLLOWING SIMPLE SUTURE OF AN ACUTE PERFORATION *

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THERE is a prevalent idea that an acute perforation of an ulcer of the stomach or duodenum will result in the spontaneous disappearance of the ulcer. For this reason many surgeons claim that all that is necessary in a case of acute perforation is simple closure of the perforation in order to prevent leakage of gastro-intestinal contents. They consider gastro-enterostomy as an unnecessary, rather dangerous procedure in these cases.

I think we can safely say that operative recoveries are not impaired by an immediate gastro-enterostomy. Reports have been published by advocates of the simple suture method, showing the good operative results of that procedure and warning against the extensive use of gastro-enterostomy in these cases. Shea¹ has reported a series of 9 consecutive cases without death in which he performed simple suture. Gibson² has reported 14 cases with one death; thirteen of these cases had simple suture. On the other hand, Deaver,³ who is a strong advocate of immediate gastro-enterostomy, has reported 25 cases with one death. My personal series comprises 10 consecutive cases without a death. Eight of these ten cases had a gastro-enterostomy performed. Two of the patients were operated upon in 1919, one in 1918, two in 1917, two in 1916, and three date back to 1915. Seven of the patients have been reexamined during the last few months, whereas I was unable to trace three (one simple closure, two gastro-enterostomies). The seven cases which I reexamined consisted of one simple suture and six gastro-enterostomies. All the six cases that had gastro-enterostomies performed are entirely well. They are now free from all the symptoms from which some of them had been suffering for years previous to the perforation. The seventh case (simple closure on account of very bad general condition, July, 1919) is still complaining of pains and fullness in the epigastrium and occasional vomiting. The X-ray shows a considerable residue in the stomach after six hours. I have advised him to have a gastro-enterostomy performed.

* From the Wimpfheimer Division for Gastro-enterological Surgery (Service of Dr. A. A. Berg), Mount Sinai Hospital.

¹ Shea: A report of nine successive operations for perforated gastric and duodenal ulcers. *ANNALS OF SURGERY*, 1916, 64, 410.

² Gibson: End-results of fourteen operations for perforated gastric and duodenal ulcers. *Surg., Gyn. and Obst.*, 1916, 22, 388.

³ Deaver: Acute perforated duodenal and gastric ulcers. *ANNALS OF SURGERY*, 1913, 57, 703.

Up to the present he has not consented to a secondary operation.⁴

The main points which have been dwelt upon by the opponents of immediate gastro-enterostomy are the spreading of infection and the undue lengthening of the operation. The spreading of infection is a more or less theoretical objection. If the perforation has occurred into the free peritoneal cavity, the whole peritoneum is already infected and the gastro-enterostomy does not spread the infection. If we are dealing with a walled-off perforation and a localized peritonitis, the rest of the peritoneal cavity can be safely protected by packing; the gastro-enterostomy can then be done in a clean field. A gastro-enterostomy can be performed so rapidly that the small loss of time will not play any rôle in the operative end-results. The Murphy button ought to be used in cases of acute perforation, as this method requires less time than a suture gastro-enterostomy.

The great advantage of an immediate gastro-enterostomy, especially if combined with a pyloric exclusion, is based on the fact that the after-treatment (feeding of the patient) is considerably simplified as compared with simple closure. The main advantage, however, of immediate gastro-enterostomy in cases of acute perforated pyloric or duodenal ulcers is the curative effect on the ulcer. The perforation, usually pin-pointed in character, occurs in the centre of the ulcer. In the majority of cases we encounter a rather large indurated area surrounding the perforation. In closing the perforation we approximate the normal serosa and muscularis surrounding the ulcer, and thus push the ulcer-bearing area into the gastrointestinal lumen. The ulcer, however, is still exposed to the traumatic injuries of the food and to the anomalies of the stomach (hyperacidity).

There can be no doubt that simple closure of the perforation will fail to cure the patient in a large number of cases. I have had occasion to observe four such cases in the short period of two years. These cases had, with the exception of one case (Case II), been previously operated upon in other hospitals for perforated ulcers. In every instance the operative procedure consisted in simple closure of the perforation and drainage of the peritoneal cavity. They were admitted to Mount Sinai Hospital because of the persistence of symptoms after the performance of the operation (simple suture).

CASE I.—S. M., aged forty-one years; admitted March 9, 1917; discharged March 31, 1917.

Diagnosis.—Pyloric stenosis and post-operative ventral hernia.

History.—The patient was operated eight years ago for perfor-

⁴I reoperated upon this patient in June, 1920. He had a perforated duodenal ulcer, walled off by the under surface of the liver. The opening admitted a lead pencil. The operation consisted of closure of the perforation, suture gastro-enterostomy and pyloric exclusion. He made an uneventful recovery. The simple closure of the perforation had neither effected a cure of the ulcer nor prevented a recurrence of the perforation.

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ated ulcer. He has complained for the last three years of hunger-pain, nausea, and constipation.

X-ray Examination.—The stomach is markedly ptosed; its tone is fair, and the peristalsis normal. The duodenal bulb is complete and somewhat tender. The motility of the stomach is practically normal. A slight residue is present after six hours. The findings are suggestive of duodenal ulcer.

Operation (Doctor Berg).—March 13, 1917. Stomach and duodenum are densely adherent to the anterior abdominal wall. The adhesions are very thick around the pylorus. They were carefully liberated. Typical gastro-enterostomy; ventral hernioplasty.

Post-operative Diagnosis.—Pyloric stenosis due to adhesions.

Reëxamination, February 20, 1920: The patient has felt perfectly well since the second operation. All his previous symptoms have disappeared.

CASE II.—J. B., aged thirty-nine years; admitted January 21, 1917; discharged February 9, 1917.

Diagnosis.—Duodenal ulcer.

History.—Patient was operated upon at Mount Sinai Hospital by Doctor Berg in 1912 for perforated duodenal ulcer, with diffuse purulent peritonitis. The operation at that time consisted in suturing the defect and in extensive drainage. The patient was free from attacks for two years. He has complained since 1914 of abdominal cramps coming on two or three hours after meals and lasting one hour, occasionally accompanied by vomiting. He has frequent gaseous eructations. He suffers from constipation. He has lost about 13 pounds.

X-ray Examination.—The duodenal bulb is complete, the peristalsis very active. There was no tenderness over the stomach nor over the duodenum. The X-ray examination does not warrant the diagnosis of recurrent ulcer.

Operation (January 27, 1917) (Doctor Berg).—A large indurated ulcer with a definite crater was found in the first part of the duodenum just beyond the pylorus. A typical suture gastro-enterostomy, combined with a pyloric exclusion, was performed. Uneventful recovery.

Reëxamination.—July, 1917: Patient feels perfectly well and has been relieved of all previous symptoms.

A reëxamination at the present date is impossible, as the patient is serving a five years' sentence in the State Prison.

CASE III.—S. B., aged forty-two years; admitted February 28, 1918; discharged March 24, 1918.

Diagnosis.—Duodenal ulcer.

History.—The patient was operated upon one year ago for perforated ulcer of the stomach. The symptoms (pains after meals and belching) persisted after the operation. He does not vomit. The symptoms became worse in the last few weeks (frequent belching and sour eructations).

X-ray Examination.—The stomach is markedly ptosed, its tone is poor. The peristalsis is hyperactive with marked incisures around

the pylorus. The duodenal bulb was not seen fluoroscopically. Its appearance on plates is rather irregular. The motility of the stomach is delayed, a slight residue being present after six hours.

Operation (March 2, 1919) (Doctor Berg).—A small ulcer is present in the duodenum. The ulcer was excised and the opening closed with chromic gut. Button gastro-enterostomy and pyloric exclusion. The specimen shows a small hard ulcer, with the suture material from the previous operation *in situ*.

Post-operative Course.—The patient developed a hemiplegia and aphasia on the third day post-operative. His post-operative course, as far as the abdomen was concerned, was uneventful. He was discharged from the hospital March 24, 1918.

Reëxamination.—March 1, 1920: The second operation has resulted in complete relief from all his abdominal symptoms. All the severe symptoms which persisted after the first operation have disappeared entirely. He eats everything. He is still suffering from a slight amount of aphasia.

CASE IV.—A. W., aged thirty years, admitted February 13, 1919; discharged March 15, 1919.

Diagnosis.—Pyloric ulcer.

History.—The patient was operated upon ten months ago for perforated gastric ulcer. The symptoms subsided for three months, then recurred. She complains of burning pains in the epigastrium, which have no definite relation to meals. She has distinct remissions of her symptoms. The pain is often followed by vomiting, which relieves the pain. No hæmatemesis. Bowels are markedly constipated. She is very weak and has lost considerably in weight.

X-ray Examination.—Shows a markedly dilated stomach and increased peristalsis. There was a slight irregularity of the gastric contour in the region of the pylorus. The duodenal bulb could not be visualized properly. No food was seen passing the pylorus during the first twenty minutes. After that period the food started to pass the pylorus, but very slowly. The motility of the stomach was delayed, a marked residue being present after six hours.

The dilated stomach, the irregularity of the pyloric region, the increased peristalsis, the inability to visualize the bulb, and the delayed motility suggest a lesion in the pyloric region.

Operation (March 1, 1919) (Doctor Lewisohn).—The stomach was found to be adherent to the anterior abdominal wall. A large ulcer was found on the anterior wall of the stomach near the lesser curvature, in the region of the pylorus. The ulcer was hard, about the size of a hazelnut. It showed a scar on the serosa, where it had perforated previously. Suture gastro-enterostomy and pyloric exclusion.

Reëxamination (March 1, 1920).—The patient feels perfectly well. The symptoms (pains, vomiting) from which she was suffering after her first operation have disappeared entirely.

These four cases show that the theory that a perforation will automatically cure an ulcer is incorrect. In two of our cases the symptoms

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persisted for eight and five years, respectively, and the patients were promptly relieved of their symptoms after the performance of a gastro-enterostomy and pyloric exclusion. In one case the ulcer was excised; the other cases did not lend themselves to this procedure.

The findings in the first case did not show an ulcer, though it is very possible that a small ulcer was overlooked on account of the dense adhesions around the pylorus.

It is customary to drain the peritoneal cavity after the closure of the perforation. This drainage (tube or packing) is apt to cause the formation of adhesions between the pylorus and duodenum, the neighboring organs (liver and gall-bladder, etc.), and the anterior abdominal wall. Thus the outlet of the stomach becomes partly obstructed and its motility is delayed. Gastro-enterostomy will safeguard proper drainage in spite of the formation of these adhesions.

CONCLUSIONS

1. Immediate gastro-enterostomy in the treatment of perforated pyloric and duodenal ulcers does not increase the mortality.
2. Gastro-enterostomy and pyloric exclusion simplifies the post-operative treatment considerably.
3. Simple closure of the perforation will not cause a cure of the ulcer in a considerable number of cases.
4. Gastro-enterostomy will guarantee proper drainage of the stomach contents and overcome partial obstruction of the pylorus caused by post-operative adhesions.
5. Closure of the perforation, gastro-enterostomy, and pyloric exclusion should be the method of choice in the treatment of perforated pyloric and duodenal ulcers. Simple closure of the perforation should be reserved for only those patients whose general condition is so poor that even a rapidly performed gastro-enterostomy would be too much of an operative risk.

CARCINOMA OF THE DUODENUM

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CARCINOMA of the intestine is quite rare, forming a very small percentage of all carcinomata. Brill estimates 2.5 per cent. The Mayo Clinic reports 3 per cent. Jefferson reports 3.1 per cent., while Geiser reports 4 per cent. A variety of explanations have been offered for this rarity by various authors, all in accordance with their views on the cause of cancer in general. Some believe that the liquid nature of the contents of the small intestine gives its mucosa a freedom from trauma, as compared with the large intestine. Others hold the abundance of the pancreatic secretion responsible. Those who uphold the parasitic theory believe the comparative sterility of the small intestine has an influence. The imperfect knowledge as to the origin of cancer in general makes such speculations idle.

Inch for inch the site of election for carcinoma of the small intestine seems to be the duodenum, though its total occurrence in the jejuno-ileum is slightly greater than in the duodenum, as shown by the following table:

TABLE I

	Duodenal	Jejuno-ileum
Köhler	9	3
Mayo	5	17
Nothnagel	7	11
M. Müller	6	3
Rüpp	1	1
Barnard	5	10
Lubarsch	2	2
Fr. Müller	6	2
Maydl	2	4
Schlieps	20	16
	63	69
	47.7 per cent.	52.3 per cent.

The rarity of carcinoma of the duodenum is well shown in Table I of the hospital autopsies following death from all causes.

This table shows a percentage of 0.033 for duodenal cancer.

In the duodenum the distribution of carcinoma is quite striking. Geiser reports 71.8 per cent. in the second part, while Fenwick reports 57 per cent. and Rolleston 67 per cent. Carcinoma of the second or papillary portion of the duodenum is extremely hard to differentiate from carcinoma of the ampulla—at operation or autopsy—so rapidly do they destroy

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TABLE II

Autopsies		Duodenal carcinoma	
Maydl	20,480	Wiener Allgemeines Krankenhaus	2
Nothnagel	21,358	Pathologic Institute, Vienna	5
Perry-Shaw	17,652	Guy's Hospital	4
W. S. Fenwick	19,518	London Hospital	18
McGlinn	9,000	Philadelphia General Hospital	1
Achleringer	42,000	Vienna	7
M. Müller	5,621	Berne, 1886-1891	6
Fr. Müller	11,314	Basle, 1874-1904	6
Rüpp	4,248	Zurich	1
	151,201		50

all traces of their origin. Ampullary carcinoma has been thought very uncommon, but the preponderance of the peri-ampullary cancers in the duodenum would lead one to believe that many of them have their origin in the ampulla, and are not true duodenal cancers at all. The first part is affected somewhat more frequently than the third, as shown by the figures of Geiser, 11-9; Forgue and Chauvin, 17-12; Fenwick, 11-7, and Rolleston, 8-3. They are usually cylindrical-celled adeno-carcinoma from the intestinal mucosa. Various theories are advanced as to their origin. Orth believes they arise from Brunner's glands, others consider pancreatic rests found in about 1 per cent. of autopsies to be the points of origin, while some believe aberrant stomach glands to be the primary site. Some emphasis has been laid on old duodenal ulcer as a causative factor in cancer of the first part. Lichty has reported six cases of carcinoma of the first part, none of them at the usual site of duodenal ulcer. He also states that the incidence of carcinoma arising on duodenal ulcer is as 1-80, while that of gastric cancer on old ulcer is as 1-2¼. Jefferson has been able to collect only thirty-one cases—some of them very doubtful, and concludes that the relationship of duodenal ulcer to duodenal carcinoma is extremely difficult to establish.

In reporting the following cases we are conscious of the fact that two of them should not be classed as duodenal carcinomata. The first two cases are primarily carcinoma of the bile-duct with secondary involvement of the duodenum, and really should be definitely distinguished from carcinoma of the duodenum when estimating the frequency of the latter lesion. This is a very frequent error, as many of the reported cases evidently arise from the bile-duct, and we are reporting these two cases to emphasize this point. The two remaining cases are definitely primary in the duodenum, and should be added to the proven cases of the disease.

CASE I.—H. S., aged forty-six years, male. Admitted to the Buffalo General Hospital April 10, 1916, complaining of increasing jaundice, pain and discomfort in the upper abdomen. The jaundice began about six weeks prior to admission, but the pain and discomfort were of long duration, having led to a diagnosis of cholecystitis several years before admission. Had lost weight in the past few

weeks. Operation revealed a small mass at entrance of the common duct into the duodenum. Common duct dilated, probe inserted revealed no stone. Cholecystostomy done. Patient died a few days after operation. Autopsy showed a small growth at the papilla of Vater, which on microscopic examination proved to be carcinoma.

CASE II.—A. C., aged sixty-eight years, male. Admitted to the Buffalo General Hospital February 5, 1910, under the care of Dr. Charles G. Stockton. Patient in very poor condition, complaining of nausea, vomiting, jaundice, and loss of weight. Until a few months before admittance he had been in perfect health. He first began to be troubled with nausea and vomiting after meals—not accompanied by pain, but becoming progressively worse. At admission he was unable to retain anything. He became markedly jaundiced shortly after the onset of his symptoms, and had continued so. Had lost a great deal of weight. Stomach showed typical carcinomatous findings. No palpable mass, stomach not dilated. Operation under very light anæsthesia showed a large carcinoma of the duodenum, involving the entrance of the bile-ducts. The condition of the patient was desperate, so that a hurried anterior gastro-enterostomy was done, and the wound closed. The patient rallied after the operation, but died suddenly the following morning. No autopsy allowed.

CASE III.—A. G., aged fifty years, female. Admitted to the Buffalo General Hospital October 16, 1918, with a history of upper abdominal pain, for a period of three or four months—particularly after taking food. This had necessitated a change of diet, until at admission she was taking only semi-solids and fluids. There had been no evidence of pyloric obstruction. She had lost about 30 pounds in weight in the past three months. X-ray examination negative, as was also fluoroscopic examination. There was no palpable mass. Operation showed mass infiltrating around lower border of liver, and connecting with the duodenum. Pylorus entirely free, the connection being about one and one-half inches below it. The mass was considered inflammatory from a perforated ulcer, and was broken into for the purpose of drainage. No pus was found and as the interior of the mass looked malignant, a piece was removed, which on microscopic section proved to be carcinoma of the duodenum. A tube was put into the opening of the duodenum, and the patient given fluids through this for a few days. There was an uneventful recovery. The patient left the hospital and has not been heard from since.

CASE IV.—A. M., aged forty-six years, male. Admitted to the Buffalo General Hospital October 28, 1918, with history of old stomach trouble of mild character. In the last few months this had grown worse, with increasing inability to retain solid food, until at admission, could retain only fluids. Had lost 49 pounds in weight in the last few months. There was no jaundice. X-ray showed an obstruction apparently at the pylorus. Wassermann negative. Operation revealed a hard mass about two inches below the pylorus, about the size of a walnut; further exploration showed a second-

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ary mass in the liver; this was about the size of a marble. Posterior gastro-enterostomy was done, the patient making a good recovery. After leaving the hospital the patient was put on intensive anti-syphilitic treatment, but without benefit. He died about four months later, extremely cachectic.

BIBLIOGRAPHY

- Fenwick, W. S.: Cancer and Other Tumors of the Stomach. London, 1902.
Maydl-Nothnagel: Diseases of the Peritoneum. Am. Med. Assn., 1905.
Mayo, W. J.: Carcinoma of the Gastro-intestinal Tract. Collected Papers of the Mayo Clinic.
Brill: Primary Carcinoma of the Duodenum. Am. Jr. Med. Scs., November, 1914, cliv, p. 824.
Rolleston: Carcinomatous Stricture of the Duodenum. Lancet, 1901, i, p. 1121.
Geiser: Ueber Duodenalkrebs. Deutsche Zeits. Chir., 1907, lxxvi, p. 41.
Forgue-Chauvin: Le Cancer Primitif et Intrinsèque du Duodenum. Rev. de Chir., December, 1915.
Jefferson: Cancer of Supra-papillary Duodenum. British Journal of Surgery, October, 1916.
Lichty: New York State Journal of Medicine, November, 1918.
Orth: Lehrbuch Spec. Pathology, 1887, 1, p. 850.
Kohler: Quoted by Eichorst in Handbuch der Speziellen Pathologie und Therapie. Wien, 1887, Bd. ii.
Müller, M.: Beiträge zur Kenotness der Metast-cisenbild Malig. Tumoren. Berne, 1892.
Müller, Fr.-Rüpp: Quoted by Hinz. Ueber den Primären Duodenalkrebs. Arch. of Clin. Chir., 1912, xcix, p. 305.
Barnard: Contributions to Abdominal Surgery. London, 1910.
Lubarsch: Ueber den Primären Krebo des Ileum. Virchow's Arch., 1888, xi, p. 280.
Schlieps: Beiträge z. klin. Chir., 1908, lviii, p. 722 (Lit.).
Perry-Shaw: On Diseases of the Duodenum. Guy's Hosp. Rep., 1893, 1, p. 274.
McGlinn, quoted by Outerbridge: Carcinoma of the Ampulla of Vater. ANNALS OF SURGERY, 1913, lvi, p. 402.
Schlerenger, quoted by G. D. Head: Am. Jr. Med. Scs., 1919, No. 2, clvii, p. 182.

PTOSIS OF THE THIRD PORTION OF THE DUODENUM WITH OBSTRUCTION AT THE DUODENO-JEJUNAL JUNCTION *

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PATHOLOGIC descent of the third portion of the duodenum associated with obstruction at the duodeno-jejunal junction has been given almost no attention by the numerous students of visceroptosis. That there are many individuals suffering from chronic digestive disturbances because of this condition is certain. The symptoms may vary in severity from occasional mild attacks of nausea and vomiting to an almost constant invalidism from duodenal obstruction and retention. The symptoms may simulate cholecystitis, gastric or duodenal ulcer or appendicitis, and patients have been operated under such mistaken diagnoses, but, of course, without the expected relief.

The writer has had the opportunity to operate on several patients for this condition and the results have been so satisfactory that a more careful study of the symptoms, causes, methods of diagnosis, and the technic of surgical relief has seemed highly justified.

The usual symptoms are: Epigastric distress or pain beginning and lasting a variable period after meals; periodic attacks of headache; nausea and vomiting of bile—the classic “bilious attack.” The pain is usually not severe enough to incapacitate the patient from work, except during the period of vomiting. During these attacks a couple of days may be spent in bed before the duodenum ceases to regurgitate. Fluoroscopic examination of the stomach and duodenum with barium meal will demonstrate the low situation of the dilated loop, as well as the obstruction to the emptying of the duodenum.

At operation the dilated duodenum may protrude into the abdominal cavity like a large pouch below the transverse mesocolon. The jejunum is abnormally small and the obstruction at the duodenal junction is plainly visible. In all the cases operated the superior mesenteric vessels and an abnormal ingrowth of fibrous bands along these vessels have been the apparent immediate cause for the obstruction. More fundamental causes will not be discussed at this time.

In view of the futility of medical treatment in the more aggravated cases and of the impossibility of relieving the obstruction satisfactorily without causing damage to the superior mesenteric artery, a short-circuiting operation was adopted. Duodeno-jejunostomy was made between the bulging duodenum and the descending jejunum. This operation was made in five patients in the years 1916 and 1917. The results have been all that could be desired in the four patients who have been

* Subject presented at the Western Surgical Association, December 19, 1919.

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under observation. No report has been obtained from the fifth, but on leaving the hospital this patient was apparently cured from a previous p. c. nausea and distress.

The following clinical history describes one of the two most aggravated of the five cases. A correct diagnosis was not made before incision. With more röntgenologic experience it has been possible later to diagnose the trouble by means of the fluoroscope. It is believed that this pathologic condition of the duodenum is a disease not at all uncommon, and that more careful search with fluoroscope and more diligence in abdominal exploration will prove this belief to be well founded.

E. N., school girl, seventeen years old. With the exception of scarlet fever and measles she was in normal health until about the age of eight, when present trouble began. Chief complaint: "Pain in stomach." During first three or four years the pain would come on immediately after eating and last one-half to one hour. The pain seemed to be worse every second day and was often associated with vomiting of bile. After profuse emesis there would be a certain amount of relief for a day. During the next four or five years the pain and emesis were less constant, but there was vomiting of bile at least once a week. Appendectomy made three years ago did not give relief. The pain has become much worse during the past three months. It is present after each meal and sometimes before breakfast. Quality of food makes no difference. It is worse when riding than when walking. She has a constant, dull headache. Vomiting of bile takes place almost daily and is followed by relief from pain until after the next meal. Bowels are constipated and move only every two to five days. Laxatives increase pain.

Family History.—Father died from accident. Mother well, but thin and looks poorly nourished; has had "poor digestion" always. Brothers and sisters well.

Examination.—Girl rather small in stature, thin and anæmic; narrow chested, thoracic organs normal. Abdomen somewhat prominent, muscles relaxed. Narrow through epigastrium; evident ptosis of stomach and intestines. Very tender to deep palpation in epigastrium and to right of navel. Gall-bladder region not tender. Ptosis of both kidneys. Blood examination showed a simple anæmia and the urine had a trace of albumin. Test meal showed gastric juice practically normal; barium meal and X-ray proved a ptosis of the stomach and to a point near pubes. There was no retention in the stomach and no abnormality found in its walls, but part of meal was found in second portion of duodenum. Most of meal was in ileum (partly confused, no doubt, with the unsuspected descended loop of duodenum), and some in cæcum, both lodged in the pelvis. It was surmised that a chronic ulcer of the duodenum with possible adhesions and traction caused the chief symptoms, and operation advised.

Operation (November 25, 1916).—Median incision. Examination of stomach on both sides negative, except for its abnormal descent. Duodenum showed no evidence of ulcer, but there was a

definite membrane attached to the lower part of the descending portion and passing upward and outward to become incorporated with the under surface of the liver to the right of the gall-bladder. Gall-bladder and ducts seemed normal and were entirely free from the membrane. There were no palpable lymphatic glands about the duodenum or pylorus. The cæcum rested in the pelvis, and so did the big bulk of the small intestines. A small omental tag was adherent at the old appendiceal scar. When the transverse colon and omentum were lifted up, it was found that the third portion of the duodenum had descended from its usual situation behind the transverse mesocolon and occupied a pocket behind the peritoneum. It was markedly dilated and formed a "U" with its angle reaching to a point near the pelvic brim. The distal end passed upward to the superior mesenteric artery. This ascending part was over two inches in diameter, with a decided thickening of the walls. The dilatation ended abruptly at the superior mesenteric artery in an abnormally narrow jejunum. The dilated duodenum contained fluid and gas and formed a pouch which extended forward into the abdomen, the small jejunum and its mesentery resting against the side of the pouch. It was clear that the bowel was constricted at the point where it passed the superior mesenteric artery and that the constriction had been chronic enough to cause both dilatation and hypertrophy of the duodenum. Moreover, there could be no doubt as to this being the lesion causing the persistent symptoms.

An effort was made to push the duodenum upward, but to retain it in an elevated position so as to insure certain and permanent drainage past the obstruction, seemed impossible. It would have required extensive dissection and preparation of space behind the peritoneum at a higher level together with a permanent closure of the large pocket now chronically occupied by the ptosed organ. Release of the obstruction by dissection of the fibrous ingrowth about the superior mesenteric vessels would have jeopardized their function. It was concluded, therefore, to make an anastomosis between the duodenum and the jejunum, for the purpose of short-circuiting the duodenal contents. An incision one and one-half inches long was made in the peritoneum over the most prominent part of the ascending part of the duodenum. The duodenum was pulled out sufficiently through this incision to permit easy placing of two rows of sutures, an outer linen and an inner chromic catgut—Quain's sewing-machine stitch—around an opening one inch long through the duodenal and jejunal walls. A few plain catgut sutures fastened the margins of the peritoneum to the suture lines and obliterated the small gap between the two loops of bowel above the anastomosis. The wound was closed and the patient made a rapid and uncomplicated recovery.

All abdominal symptoms, with the exception of a continued sluggishness of the bowels, disappeared after the operation. Final results, December, 1919, three years after operation: Had no further stomach trouble; general health excellent; gained 30 pounds in weight; graduated from Normal School.

JEJUNO-COLIC FISTULA *

BY MARTIN WARE, M.D.
OF NEW YORK, N. Y.

THE unique characteristics of this case without a parallel in literature, precisely diagnosticated before operation and successfully dealt with, urge the narrative thereof.

Past History.—J. K., aged fifty-five years, operated thirteen years ago for hemorrhoids. Five years ago Dr. I. Haynes resected 6 inches of transverse colon and performed a lateral anastomosis for the removal of an annular carcinoma which manifested itself with symptoms of intestinal obstruction. Forty-eight hours after operation fecal vomiting and hiccup set in and persisted for two weeks at intervals. Seven days after operation fecal discharge appeared on the dressings. At the expiration of the third week patient left the hospital. The abdominal wound had given way to a large extent, and because of the continued drainage for two months a long healing of the wound followed. Three months after the operation patient gained thirty pounds. Another three months he began to complain of pains, unlike the colicky pains before operation, referred to the left of the umbilicus—digestion and bowels operate regularly. He continued gaining weight up to one year after operation, and within the next six months he fell off in weight. About this time (two years after operation) liquid movements day and night, much flatus, borborygmi, and attacks of pain set in with slight bleeding.

Physical Examination.—Doctor Haynes vouches for the fact that palpation did not disclose any tumor mass, and Dr. S. Unger, who conducted X-ray examination, reports colon is normal in outline with apparently no obstruction in the entire length. In the prone position the transverse colon is normal, but in the erect posture it is completely ptosed and encroaches on the sigmoid and rectum. There are no signs of adhesions at either hepatic or splenic flexure.

Present History.—July, 1919. In 1917, two years after the operation cited above, Mr. J. K. rapidly and progressively lost weight and flesh, notwithstanding a voracious appetite offset by copious diarrhoeal movements shortly after the ingestion of food throughout the day and night. These were accompanied by borborygmi and visible peristalsis and great tympanites and a reduction of weight to 97 pounds. In addition there was a ventral hernia due to a diastasis of the recti M.M. throughout the length of the abdomen.

Believing at first that the diarrhoeal condition was due to some ulcerative or catarrhal process, I gave large doses of bismuth subnitrate and atropin. The diminution of stool was but temporary.

* Presented before the Surgical Section of the New York Academy of Medicine, April, 1920.

There was no febrile movement and the patient presented the picture of inanition. This latter impression, together with the pertinent statement of the patient that "what struck him peculiar was that he was possessed of great hunger and that his food seemed to go right through him," led me to the assumption that there was perhaps a communication somewhere between the small intestine and the large gut, due to a perforation from recurrence of the carcinoma. At no time was the stool formed and always accompanied by much flatus, the expulsion of which relieved him. I had recourse to X-ray examination. The report of Dr. C. Gottlieb follows:

Radiographic Examination.—The radiograms obtained either with the barium contrast meal or enema did not disclose any filling defect or stricture characteristic of a recurrence of the carcinoma. On the other hand, the large intestine was conspicuously dilated in its entire continuity. In the screen and in the picture, the barium injected (Fig. 1) or ingested (Fig. 2) was seen to pass from a loop of small intestine high up into the large intestine near the splenic flexure, and *vice versa*. This loop of small intestine shows the striations of the barium-coated valvulae conniventes by which it was identified. It was dilated, but not so much as the large gut. The outline of the balance of the intestinal tract is wanting. In fact, the ingested barium did not even reach the ileum to sufficiently outline its transition into the cæcum.

The X-ray confirms and locates a communication between a loop of the small intestine, high up, by a small ostium, with the large gut in the vicinity of the splenic flexure.

Operation.—Upon laparotomy by an incision extending the entire length of the abdomen there was no evidence of fluid or scattered miliary deposits of carcinoma. The liver surface and substance were free of any nodules. No enlarged glands encountered in the mesentery or transverse mesocolon. Some adhesions enveloping the omentum, small intestine, and colon were divided. A large extent of small intestine identified as ileum leading down towards the cæcum was found collapsed. A loop of gut identified as jejunum adjacent and intimately fused with the large dilated big gut, proximal to the splenic flexure was divided along the line of adhesion, thereby disclosing the stoma. The defect in both the jejunum and the colon, the size of a lead-pencil, was closed by a purse-string of chromic gut reinforced by a Lembert suture of the same material. Exploration of the site of the lateral anastomosis failed to reveal any evidence thereof other than a larger extent of dilatation in the transverse colon than obtained in the rest of the extent of the colon. Even the transverse mesocolon appeared normal and the haustræ could be traced uninterruptedly over the colon. To overcome the wide diastasis of the recti the abdomen was closed by overlapping side to side of the sheath harboring the atrophied recti.

Post-operative Course.—Within twenty-four hours the diarrhœa so incessant by day and night ceased, never to return. After the fourth day in the face of primary union a light diet was instituted, in turn followed by regular diet. On the fifth day the bowels were first



FIG. 1.—Bismuth enema passing from splenic flexure into small intestine outlined by striations of valvulae conniventes.



FIG. 2.—Bismuth test meal passing from stomach leaving empty the ileum and being driven into colon by way of jejunal fistula.



FIG. 3—Bismuth enema recently given showing normal conditions.



JEJUNO-COLIC FISTULA

moved by pituitrin given intravenously. Thereafter they were made to move by laxatives which were abandoned, owing to the speedy return to spontaneous movements. By the tenth day the patient began to feel stronger. At the time of leaving the hospital on the fourteenth day he was able to walk unaided, having gained 5 pounds above his weight of barely 100 pounds at the time of operation. Up to date he has gained over 40 pounds and enjoys the best of health. The barium X-ray enema of the intestinal tract (Fig. 3) shows restoration of normal conditions.

Comment.—Two and a half years after the otherwise successful operation for removal of the growth, signs of disorder relative to the fistula first became manifest. An X-ray at this time, however, did not disclose the existence of any such process, whereas with the persistence of symptoms X-rays one and one-half years later conclusively demonstrated the fistula. This long interval that lapsed between the operation and the signs of the fistula makes it unlikely that error in suture was responsible for this development. On the other hand, it is more plausible to assume the fistula as incident to the suppuration at the site of the anastomosis. Adherence between the loops of gut was inevitable, harboring a focus of infection which slowly went on to ulceration and perforation. In view of the fact that fistulous communication between the stomach and colon (gastro-colic) arises after a legitimately executed gastro-jejunostomy and which have been assigned to wandering of the non-absorbable sutures, I draw upon the Pagenstecher thread that was used for the anastomosis. Beyond this it is difficult to reconstruct the sequence of events that may have led to this jejuno-colic fistula.

**THE RELATION BETWEEN INTESTINAL DAMAGE
AND DELAYED OPERATION IN ACUTE
MECHANICAL ILEUS***

BY FREDERICK T. VAN BEUREN, JR., M.D.
OF NEW YORK, N. Y.

A NUMBER of fascinating theories have been suggested to explain the immediate cause of death in acute mechanical ileus and some of them have given real, practical assistance to the operating surgeon. The "toxæmia" theory has supported the rationality of intestinal drainage, while the "tissue desiccation" theory has affirmed the value of replacing the water lost by vomiting. But there is forced upon the mind of anyone who examines a considerable series of cases of this condition one conclusion which is of the utmost significance. Subject to certain exceptions, it might be stated as a corollary that, if the case is really one of acute mechanical ileus, the longer a patient lives with it before operation, the sooner he dies afterwards! Everyone knows this; and almost everyone acts as if he had forgotten it when he is faced with a case occurring in the convalescence of a patient upon whom he has operated for some other condition.

Acute ileus due to strangulated hernia usually receives fairly prompt attention; but a patient whose intestinal obstruction depends upon adhesion-angulation or peritoneal band-pressure arising in the course of an operative convalescence frequently waits the limit before the attending surgeon makes up his mind to perform an operation that ought to have been an early exploratory, but which often turns out to be a sort of ante-mortem examination. This paper is a thinly disguised brief for early exploration in cases of suspected acute mechanical ileus.

There are several good reasons for urging early exploration, familiar to everyone but frequently forgotten. For example, the longer the ileus exists unrelieved, the greater the patient's fluid loss, the poorer his circulation, the greater his prostration, and the worse his general condition. Moreover, it is probable that the poisonous character of the stagnated gut contents is enhanced during the interval. And it is in most cases unquestionable that the damage to the gut itself increases the longer it is obstructed. This factor was so clearly evidenced in some animal experimentation done in the course of third-year teaching at the College of Physicians and Surgeon last winter—experiments in which the duration of the obstruction was definitely known—that I have thought it worth

* From the Laboratories of the Department of Surgery, College of Physicians and Surgeons, Columbia University.

Read before the New York Surgical Society, April 28, 1920.

ACUTE MECHANICAL ILEUS

while to demonstrate the specimens here with the specific intention of urging the plea they make for early operative interference.

Fifteen dogs were operated under ether anaesthesia, and ileus was created by ligating or by dividing the jejunum within 30 cm. of its upper end. The object was to demonstrate the lesions, the course, and the treatment of acute mechanical ileus to third-year students, and care was taken to create a simple obstruction without strangulation of the mesenteric vessels. One dog died within twenty-four hours, and in two there was failure to maintain complete obstruction on account of the cutting through of the ligature; but, in the remaining twelve, complete obstruction was maintained until the intestines had been examined at operation or at autopsy. Four dogs were examined (Nos. 1123, 1169 (Fig. 1), 1173 (Fig. 2), and 1174) at the end of forty-eight hours after the onset of obstruction. Six dogs were examined (Nos. 1130, 1144 (Fig. 3), 1145 (Fig. 4), 1171, 1172, and 1131) at the end of seventy-two hours after the onset of obstruction, and two dogs were examined at later periods, No. 1173 (2) (Fig. 5) at the end of about ninety-six hours, and dog No. 1176 (Fig. 6) at the end of one hundred and eighty hours after onset of obstruction. One of the dogs, who was examined at the end of forty-eight hours and was relieved at that time by resection with lateral entero-enterostomy, showed recurrence of ileus symptoms on his fourth post-operative day, and died four days later on the night of his seventh to eighth post-operative days. Autopsy showed an angulation ileus at the site of the anastomosis, which had presumably existed about ninety-six hours. This made thirteen cases of ileus in twelve animals and accounts for No. 1173 appearing in two places in the series. Of the five intestines examined at the end of forty-eight hours or less, only one showed any gross damage. Of the eight which were examined at the end of seventy-two hours or more, all showed gross damage, excepting two of those in the seventy-two-hour group. In other words, 25 per cent. of the early group showed intestinal damage, and 60 per cent. of the late operative group showed intestinal damage. It would appear from this observation that the third twenty-four hours is a rather critical period in the course of an acute simple obstruction where no element of strangulation of the mesenteric blood supply complicates the condition. In four of these late cases the evidence of damage, aside from distention and thinning of the wall, consisted in the appearance of discolored areas varying in color from purple to green, and in size from $\frac{1}{2}$ to several cm. (Figs. 3 and 6). These areas were taken to be areas of beginning necrosis, areas of beginning gangrene, if you like, because gangrene of the intestine is no more nor less than the persistent interruption of the blood supply, accompanied or followed by the invasion of bacteria and the resultant destruction of that portion of the wall involved in the process. They are apparently dependent upon the intestinal distention, for they were found only in the markedly distended guts, and only one case of marked distention failed to show them (Fig. 4). The

distention was in all cases chiefly a gaseous one, and although the cause of the gas formation is not entirely clear, its effects are fairly apparent. The gut becomes distended to three or four times its normal diameter, with a resultant arithmetical increase in its circumference and a geometrical increase in its volume. The greater the distention of the intestine the less the residual elasticity of its wall and of the vessels in it. As for the vessels themselves, their elongation results in a narrowing of the lumen and a thinning of the walls. The thinning of the walls results in greater compressibility. These conditions are maximum at the antimesenteric border of the intestine, where the terminal vessels anastomose; and, failing any interference with the mesenteric vessels, tissue damage is earliest and most apparent on the antimesenteric surface, where these discolored areas were seen. Their shape often corresponds with the distribution of the terminal vessels; and this irregular diamond shape, with its long axis across the intestine, is fairly well seen on the closed end of the oral loop in dog No. 1176 (Fig. 6). A good indication of the same appearance is also observable in the specimen from dog No. 1144 (Fig. 3), although a longitudinal section for microscopic examination has been taken from its middle. If this necrosis extends through the wall, perforation occurs with resultant peritonitis. If the distention is relieved early enough the necrosis may remain superficial, and may heal by scar formation, or by adhesion to omentum or to other viscera. If it is relieved too late, the necrosis may progress to perforation in spite of the relief of the distention. Illustrations of these two possibilities were seen in dog No. 1123, relieved after forty-eight hours' obstruction, and in dog No. 1131, relieved after seventy-two hours' obstruction. In the forty-eight-hour case an area of beginning necrosis was seen about 8 cm. from the pylorus at operation, and after aspirating the intestinal contents by needle through it, it was purse-stringed and the obstruction relieved by resection and anastomosis. The dog recovered, and, at autopsy a month later, the duodenum was found firmly adherent to the under surface of the liver throughout the area where the necrotic spot had been seen previously. In the seventy-two-hour case several spots of beginning necrosis were seen at operation, and an effort was made to remove them by resection while the obstruction was relieved by anastomosis. The dog died forty-eight hours after the relief operation, and autopsy disclosed a diffuse peritonitis, due to duodenal perforation about 15 cm. from the pylorus, and a localized abscess around a leaky anastomosis as well.

Parallel with the increase in intestinal damage went the increase in the mortality of the operated cases in our little experimental series. Dogs Nos. 1123, 1173, 1174, and 1175 were relieved at the end of forty-eight hours. Dogs Nos. 1130, 1131, 1171, and 1172 were relieved at the end of seventy-two hours. Resection of the intestine was done in all but two of the eight cases, and lateral anastomosis was done six times, and end-to-end anastomosis was done twice. Only one of the forty-eight-hour



FIG. 1.—Dog No. 1169 (Surg. Path. No. 5935). Intestine examined forty-eight hours after onset of ileus. Longitudinal section showing obliterated lumen at ligated point and little change in thickness of wall. Distention within normal limits. No evidence of gross damage. Arrow points to removal of section for microscopic.

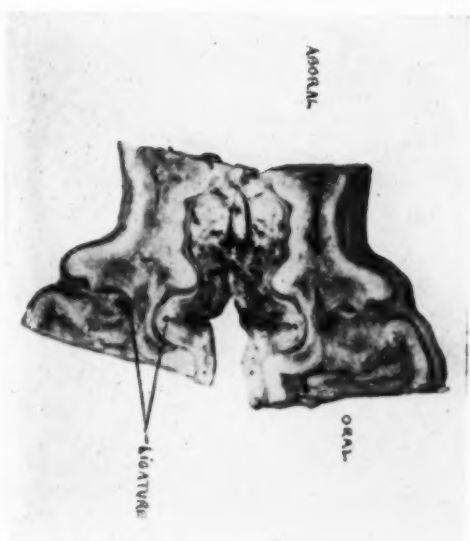


FIG. 2.—Dog No. 1173 (Surg. Path. No. 5922). Intestine examined forty-eight hours after onset of ileus. Longitudinal section showing obliterated lumen at point of ligation and little change in thickness of wall. Distention within normal limits. No evidence of gross damage.



FIG. 3.—Dog No. 1145 (Surg. Path. No. 5883). Intestine examined seventy-two hours after onset of ileus. Showing marked distention of oral segment with thinning of wall above ligature but no evidence of gross damage.

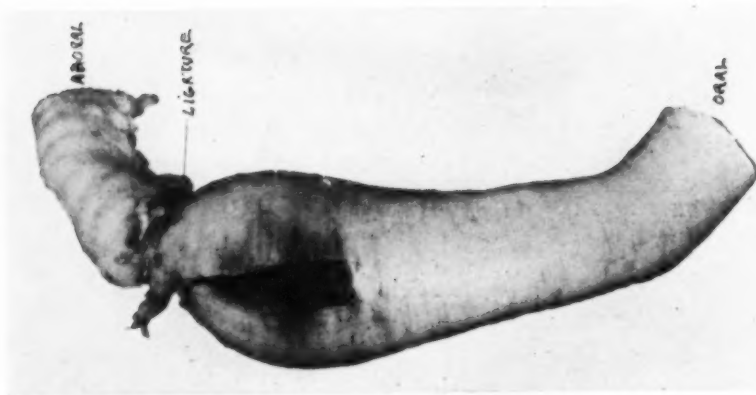


FIG. 4.—Dog No. 1144 (Surg. Path. No. 5882). Intestine examined seventy-two hours after onset of ileus. Showing distention beyond normal limit of oral segment with thinning of wall and area of beginning necrosis (roughly diamond-shaped area with long axis transverse to long axis of intestine—dark colored) through which section has been taken, exposing lumen.

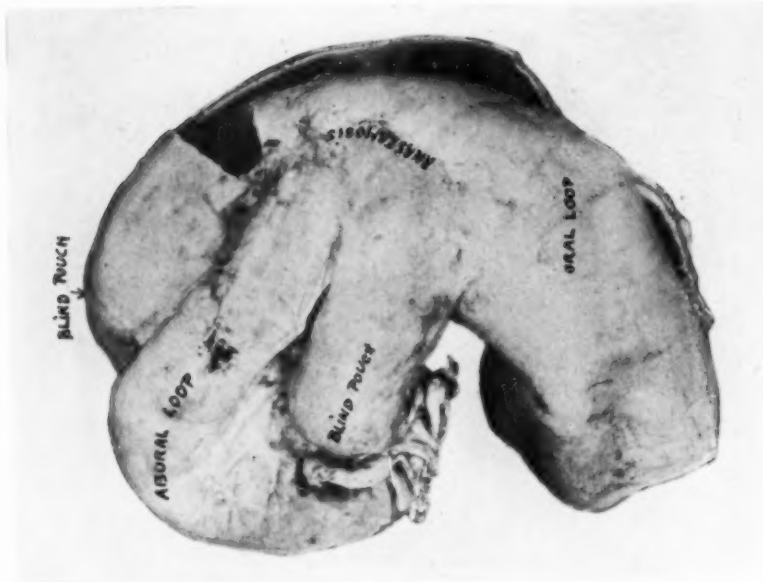


FIG. 5.—Dog No. 1173 (Surg. Path. No. 5944). Intestine examined seventy-two to ninety-six hours after onset of ileus. Showing intestinal anastomosis with distended oral and collapsed aboral segments due to obstruction of stoma from adhesion-angulation of aboral segment. Wall of oral segment markedly thinned and discolored due to distention beyond normal limits.

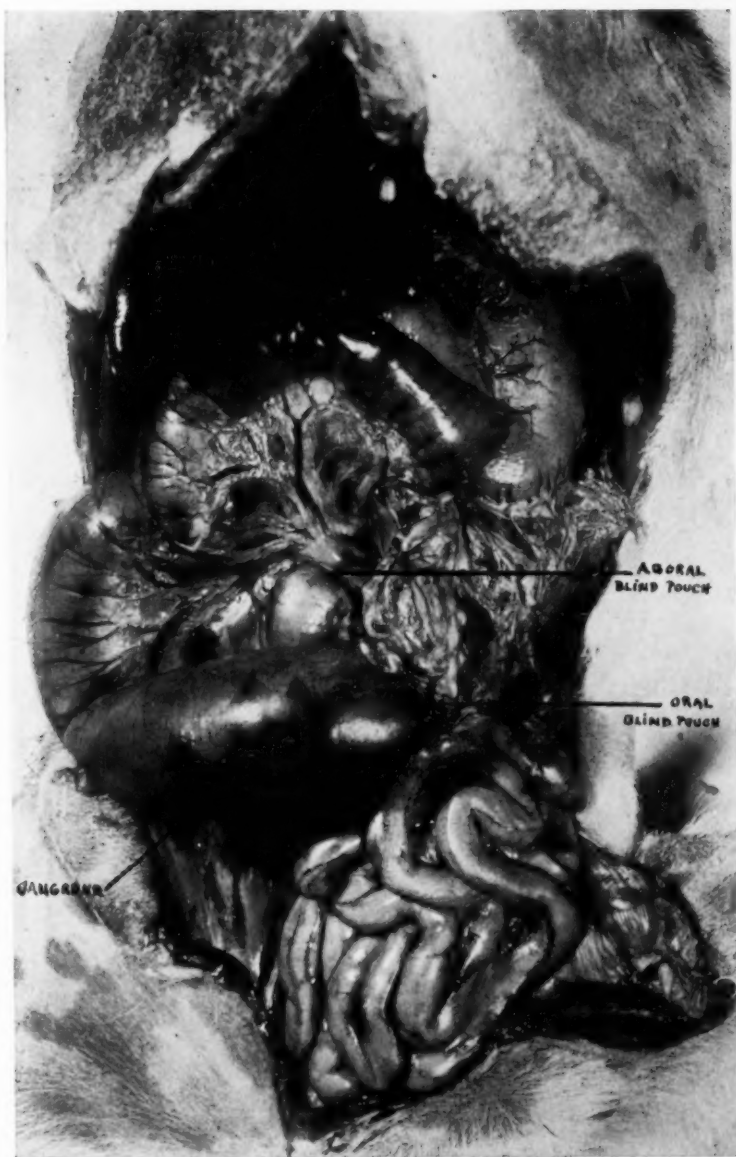


FIG. 6.—Dog No. 1176 (Surg. Path. No. 5946). Intestine examined one hundred and eighty hours after onset of ileus. Showing collapsed gut aboral to section of jejunum and distended discolored gut oral to obstructed point. Note the coalescent areas of diamond shape on the antimesenteric surface of oral segments, near inverted end due to distention beyond normal limits.



FIG. 7.—Dogs Nos. 1169, 1173, 1145, 1144, 1173, 1176. Showing relative thickness of sections taken from intestinal walls after various periods of obstruction. Nos. 1 and 2, forty-eight hours after onset. Nos. 3 and 4, seventy-two hours after onset. No. 5, seventy-two to ninety-six hours after onset. No. 6 one hundred and eighty hours after onset. The progressive thinning-out is due to the progressive distention.



FIG. 8.—Microscopic section (35D) of intestine shown in Fig. 1. All coats of wall intact except mucosa which shows some destruction of villi.

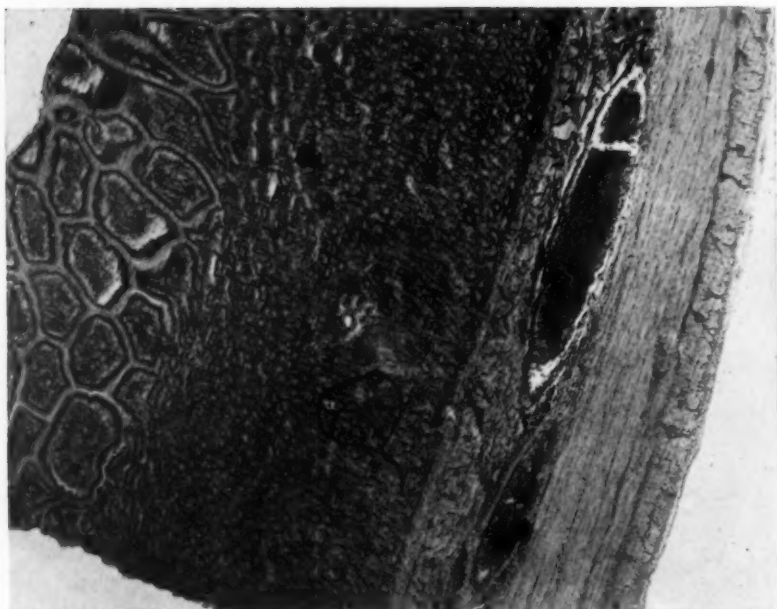


FIG. 9.—Microscopic section (35D) of intestine shown in Fig. 2. All coats intact. Note flattening of surface, due to pressure, and thrombosed vessel in submucosa.

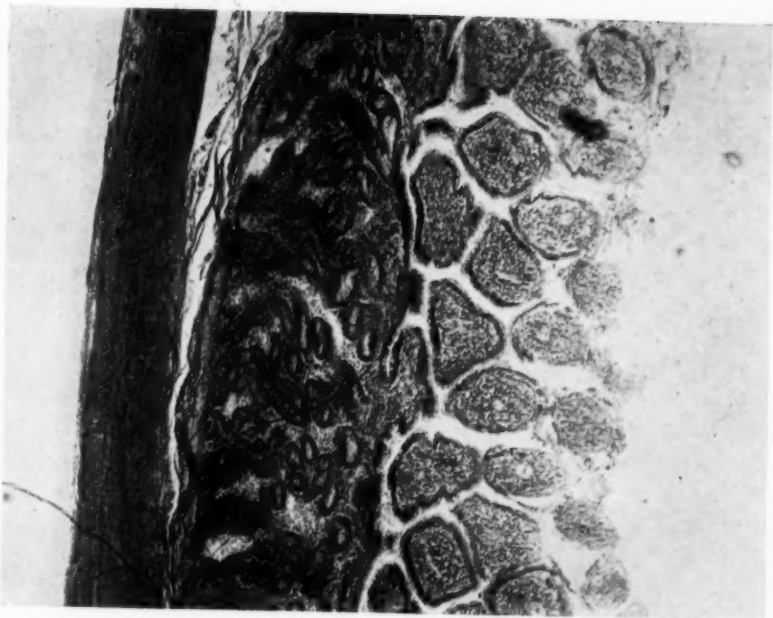


FIG. 10.—Microscopic section (35D) of intestine shown in Fig. 3. Compression and degeneration of villi; some degeneration in submucosa. Muscular coats markedly thinned out.

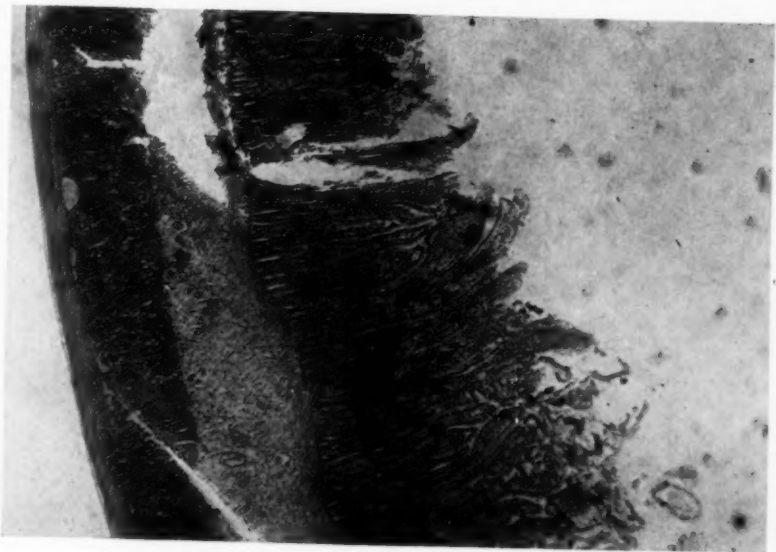


FIG. 11.—Microscopic section (35D) of intestine shown in Fig. 4. Degeneration of all coats, most marked in submucosa and internal muscular layers.

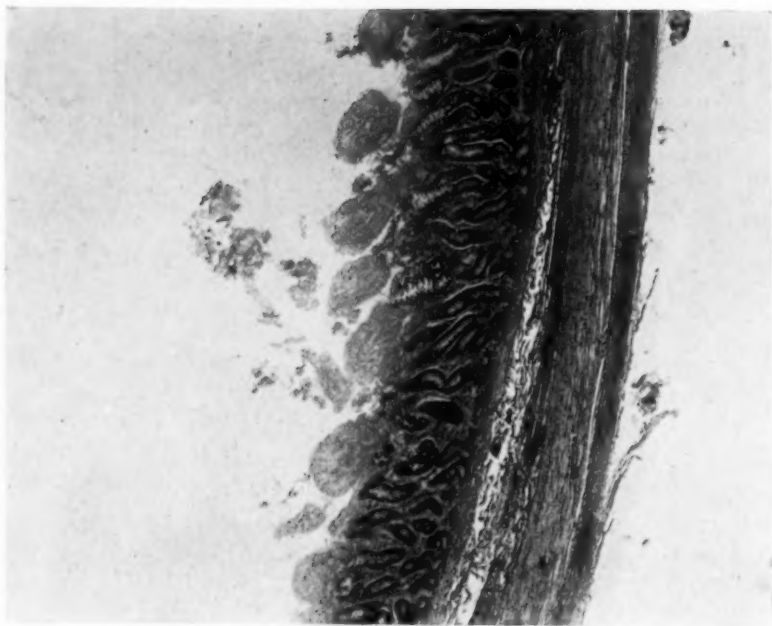


FIG. 12.—Microscopic section (35D) of intestine shown in Fig. 5. Degeneration and thinning out of all coats. Villi practically all destroyed.

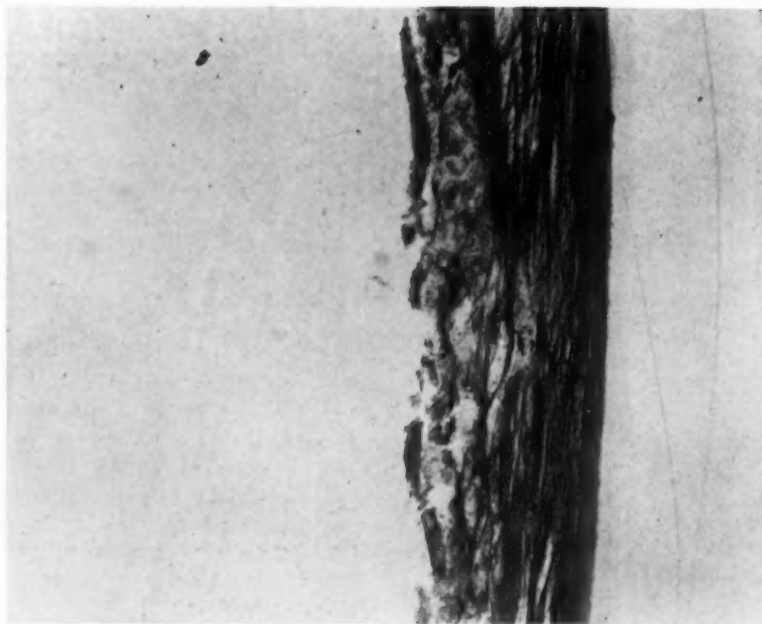


FIG. 13.—Microscopic section (35D) of intestine shown in Fig. 6. Mucosa entirely destroyed. Degeneration and partial destruction of other layers.

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operation group died—No. 1174—while only one of the seventy-two-hour group recovered—No. 1171. In other words, 75 per cent. of the forty-eight-hour obstructions recovered, and 75 per cent. of the seventy-two-hour obstructions died after operation. On the basis of such evidence as this one feels justified in urging early operation, exploratory, if you like, in cases of suspected acute ileus, without waiting for an absolutely positive diagnosis.

PROTOCOLS OF CASES REFERRED TO IN THE SERIES

Dog No. 1169 (Surgical Pathology No. 5935).

January 17, 1920: 11.00 A.M. Ileus by ligation of jejunum 30 cm. below duodenal-jejunal flexure (upper fixation).

January 19, 1920: 1.00 P.M. Died (fifty hours post onset of ileus) after showing marked symptoms of vomiting, prostration and constipation.

Autopsy.—About two hours post mortem. Local peritonitis in R. U. Q., with serosanguinolent exudate. Occlusion complete. Duodenum and jejunum oral to ligature moderately distended (2 cm. and superficial vessels congested). No evidence of permanent damage due to circulatory interference. M.M. normal to gross appearance. Intestine below ligature collapsed and pale. Pancreas pale. Apparent hemorrhage into it.

Microscopic.—Specimen taken 2 cm. oral to ligature. The wall is intact. All coats are relatively normal, although there are small scattered areas of blood extravasation and degeneration in the muscularis and submucosa and some oedema. There is quite marked degeneration of some of the villi of the mucosa.

Dog No. 1173 (Surgical Pathology No. 5922).

January 17, 1920: 11.00 A.M. Ileus by ligation of jejunum 30 cm. below duodenal-jejunal flexure (upper fixation).

January 19, 1920: 11.00 A.M. (Forty-eight hours post onset.) Relief by resection of ligated portion with lateral anastomosis of oral to aboral segments (after showing marked signs of vomiting, moderate prostration and constipation).

Operative Findings.—No leakage or peritonitis. Ligature is not visible, and smooth glistening peritoneum extends across the furrow which indicates its situation. Obstruction is complete. No signs of permanent damage due to circulatory interference. Intestine is 3 cm. in diameter above ligature and 1 cm. below it. M. M. normal to gross appearance.

Microscopic.—Specimen taken 1 cm. oral to ligature. The wall is intact. All coats are relatively normal and show no degeneration. The vessels of the submucosa are congested and some are thrombosed, and there are a few extravasations of blood in the submucosa and muscularis.

Dog No. 1144 (Surgical Pathology No. 5882).

January 3, 1920: Ileus by ligation of jejunum about 17 cm. below upper fixation.

January 6, 1920: Chloroformed after showing some vomiting, moderate prostration and constipation.

Autopsy.—Immediate. No leakage or peritonitis. Obstruction complete. Duodenum is moderately dilated and congested, but shows no marked damage till a few cm. above ligature, where a marked dilation exists (about 3 cm. in diameter) and an area of dark purplish discoloration about 1 cm. in diameter on the anti-mesenteric surface, with a surrounding area of lighter color 2 cm. in diameter. It is believed to be a beginning necrosis of the wall like that seen in other cases, one of which perforated. The wall of the dilated portion is thinned out and the m. m. directly beneath the discolored area appears to be ulcerated.

FREDERICK T. VAN BEUREN, JR.

Microscopic.—Section taken through discolored area. The wall is moderately thinned, and its integrity is threatened by a very marked degeneration of the submucosa and inner muscular coats. The serosa and outer muscular coat are relatively normal and the mucosa shows only a little degeneration of its villi.

Dog No. 1145 (Surgical Pathology No. 5883).

January 3, 1920: Ileus by ligation of jejunum about 17 cm. from upper fixation.

January 6, 1920: Chloroformed after showing very few signs of obstruction (does not eat or drink, but looks well).

Autopsy.—Immediate. No leakage or peritonitis. Obstruction complete. All organs look normal except intestine. Except for marked distention and congestion, duodenum appears fairly normal. No evidence of permanent damage due to circulatory interference.

Microscopic.—Section taken 2 cm. above ligation. The wall is moderately thinned, but its integrity is preserved. The superficial part of the mucosa is markedly degenerated and the stroma of its deeper part infiltrated by round-cells. The submucosa is thinned and partly degenerated, but the muscularis and serosa, although very markedly thinned, are otherwise relatively normal.

Dog No. 1173 (Surgical Pathology No. 5944).

January 17, 1920: Ileus by ligation of jejunum about 30 cm. from upper fixation.

January 19, 1920: Relief by resection of ligated portion and lateral anastomosis of oral and aboral segments. No vomiting for five days. On the fifth day he had a small bowel movement. None after that, and obstruction probably became complete that day.

January 24, 1920: Onset of recurrent ileus due to angulation of gut at anastomosis.

January 27, 1920: Found dead in cage seventy-two to ninety-six hours after onset of recurrent ileus.

Autopsy.—Several hours after death. Local peritonitis in R. U. Q., where loop of duodenum and jejunum are bound by soft adhesions to each other and to liver and omentum. Stomach enormously distended with gas (13 cm. in diameter). Duodenum descending moderately distended and shows purple area at middle, where it is somewhat angulated. Remainder of duodenum and jejunum above anastomosis greatly distended, progressively more so towards anastomosis, where oral segment measures 4 cm. in diameter and shows patches of purplish-green discoloration apparently beginning gangrene. Wall is thin in this area and m. m. is bile-stained and rugæ flattened. Some apparent ulceration in m. m. Aboral segment collapsed and pale, and angulated so as to form obstruction at anastomosis.

Microscopic.—Section taken from oral loop opposite anastomosis. The wall is greatly thinned out, but all coats are present, and the integrity of the wall is preserved. The villi of the mucosa are completely degenerated and the stroma of its deeper part widely infiltrated by round-cells. The submucosa is compressed and the inner muscular coat partially degenerated. The outer muscular coat and serosa are relatively normal.

Dog No. 1176 (Surgical Pathology No. 5946).

January 17, 1920: Ileus by section of jejunum (with inversion of ends) 15 cm. from upper fixation.

No vomiting observed for seventy-two hours post operation, then vomited q. d., but only moderate amount. Had one small constipated stool (one hundred and twenty hours) on fifth day post onset of ileus. Prostration grew progressively more marked and died the night of the seventh day post onset of ileus (one hundred and eighty hours, about).

January 24, 1920, or January 25, 1920: Died during the night. Found dead in A.M., January 25, 1920.

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Autopsy.—About thirty-six hours post mortem (in ice-box meantime). No leakage. No free fluid. No peritonitis except locally, where adhesions have bound duodenum to under surface of liver and jejunum; to wound in outer wall and omentum to inverted end of jejunum. Stomach pale and contracted. Duodenum and oral segment of jejunum greatly distended with progressive increase to point of section just above which a large greenish purple area of beginning gangrene appears on antimesenteric surface. This area is irregular in shape, 5 cm. long and 3 cm. in greatest width. It corresponds to the distribution of the terminal branches of the intestinal vessels. The diameter of the gut at this point is about 4 cm. and the wall reduced to approximately $\frac{1}{2}$ mm. thickness. The intestine below section is pale and contracted.

Microscopic.—Section taken through area of discoloration. The wall is extremely thin and the integrity of the wall is lost. The m. m. is absent and the inner muscular coat almost completely degenerated. The outer muscular coat and serosa retain their integrity, but show many blood extravasations.

THE ORTHOPÆDIC TREATMENT OF BURNS.*

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(From the First Surgical Division of Fordham Hospital, the Service of Dr. Alexander Nicoll)

SINCE deformities in general can be prevented the orthopædic treatment of burns should be properly emphasized and detailed. Unfortunately, however, the leading text-books pass rapidly over this phase of the problem. As a result, medical students receive very little instruction concerning this problem. It is not until they merge into general practitioners that the treatment of burns becomes of interest and moment, and even then, occasionally, the incapacitating and crippling deformities may be overlooked. Of course, the actual deformities following extensive and deep burns are well known, for these unfortunates with their disabling scars and contractures are extremely common visitors of the clinic. From these patients can be elicited, as a rule, the history of numerous and unavailing operations to correct the deformity and to prevent the recontraction of the scar tissue.

The orthopædic surgeon, by applying the braces or plaster casts commonly used in the treatment of anterior poliomyelitis, peripheral neuritis, etc., may prevent these contractures. During the war many new devices, plus the use of fenestrated plaster casts, were employed to use in similar cases. But, it would appear, that some simpler methods are desirable and applicable for the use of the general practitioner.

We have not only used extremely simple methods in the First Surgical Division of Fordham Hospital, but have gone a step further, in instructing and interesting the internes and nursing staff, with the ultimate purpose that, every patient admitted with a burn, no matter what degree, receives immediate attention upon admission. From this co-operation we have noted, to our great satisfaction, that no contractures have developed. Indeed, even the nurses in the ward, who have become acquainted with the technic, and who have learned how to keep the limbs in proper position, administer the treatment often before the patients are seen by the house surgeon. Of course, we are not discussing at present the specific methods of treating burns, such as by paraffine,

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electric light, etc., but are merely pointing out the necessity of prevention of deformities.

MacLeod, in his book on "Burns and Their Treatment," devotes but one paragraph to this topic, though he mentions that the limbs must be kept in a proper position during the process of healing. He describes the best position, but fails to mention the details as to how to place the limbs to maintain their position. Our methods, in short, are as follows: In burns of the front or side of the neck, a collar of felt is applied to maintain the head in the middle line with the chin directed upward. If there exist a tendency toward contraction of one side, the neck is pushed to the other. The collar is made of felt about three-quarters of an inch in thickness. The height of the collar corresponds, generally, to the length of the neck from the chin to the sternum. This collar is surrounded with soft felt or muslin (Fig. 1), though one may use softer material. The collar is sewed following

each dressing, although clips may be provided. We have

found that sewing is an extremely simple procedure. As a rule, the nurses after applying paraffine, etc., as a dressing, place oil skin over the wound and then apply the collar instead of bandage. The collar may be made of leather, plaster or celluloid, but since these take time to prepare, felt appears more desirable. Indeed, an ordinary stiff linen collar, with gauze beneath, may be utilized in an emergency.

In burns of the shoulder and axillæ, which are, admittedly, extremely common and which induce severe contractions, the arm must be kept in extreme abduction, in order to prevent its being drawn toward the body to produce the so-called "bat-wing" deformity. In these instances, we tie the hand in slight abduction to the head of the bed, which is elevated, so that the weight of the



FIG. 1.—Showing proper application of a felt collar in cases of burns of neck.



FIG. 2.—A severe case of burn of neck showing the marked deformities that may occur. This patient had no orthopædic treatments. The wounds are healed.



FIG. 3.—Same patient as in Fig. 2.



FIG. 4.—Same patient as in Fig. 2.

trunk tends to drag the patient downward, while the upper extremity remains in marked abduction. In order to avoid constriction of the peripheral circulation, felt may be placed surrounding the wrist before applying the bandage.



FIG. 5.—Case II. Photograph taken in January, 1920. Note the extensive scar. The limitation of abduction is still present.

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In case of a burn at the elbow, extension of the arm is maintained by securing the trunk to the opposite edge of the bed, while the affected arm is tied to the corresponding side of the bed, or even perhaps to the ad-



FIG. 6.—Case II. Photograph taken in January, 1920. Note the limitation of flexion.

jacent bed. The body is secured to the side of the bed by passing a sheet round the chest at the level of the nipple. Sandbags are extremely useful in this connection.



FIG. 7.—Case II. Photograph taken April 11, 1920. Note the good abduction.

In the case of burns of the wrist and fingers, it is extremely important to keep the adjacent raw surfaces separated, in order to prevent adhesions. We have, in some instances, applied oil silk to the wound and then

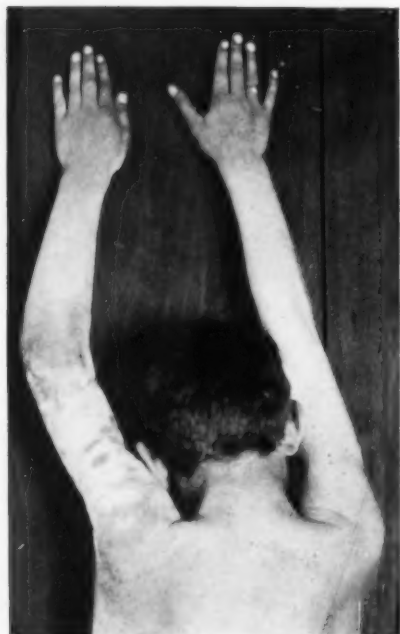


FIG. 8.—Case II. Photograph taken on April 11, 1920. Note the hyperabduction.

bing strap or flannel is applied to the back of the leg, passed over the tarsus and then crossed under the foot. The position recommended for burns in the region of the hip is also of value in case of burns of the knee.

For burns of the ankle the knee should be tied with a sheet, passing across them to the sides of the bed. A sandbag is placed next the soles of the feet in order to maintain flexion.

Recently we have made use of the Thomas Jones splints, ankle splints and cock-up splints for the knee, ankle, shoulder and elbow. The application of these splints, which has been so markedly stimulated by the war, is well known and needs no explanation. Of course, these appliances are not always at hand, and in their absence the methods we have recommended may be employed. In general, we have found that these simple methods are advantageous, in not only preventing deformities, but save the nursing force a great deal of unnecessary work, which is,

made a plaster cast to separate the fingers. This method is somewhat crude, but, as yet, we have not discovered any simpler procedure. We are, at present, experimenting with pestaline, so commonly used by dentists. The pestaline is melted in hot water and then applied with the wrist straight or hyperextended and the fingers separated. A muslin bandage is then applied. For one finger a padded tongue depressor is generally sufficient.

For burns in the region of the hip we usually tie the feet in abduction to the foot of the bed. A sheet is then placed around the chest and brought to the head of the bed. Slight Trendelenburg position is of value. A Cushing knot may be made as follows: After padding with heavy felt the tendo achillis and foot, a heavy web-



FIG. 9.—Case II. Photograph taken on April 11, 1920. Note the hyperabduction and ability to rotate outwards.

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of course, a vital point in hospital economy. Moreover, the process of healing and repair has been accelerated. The position of the limbs appear to be extremely comfortable to the patient; none of the children have complained.

If scar tissue was already present, or even beginning to form, the proper positions of the limbs were selected and gradual stretching begun. Though new epithelial layers were necessarily ruptured by this method, the results obtained have been very encouraging. Many times we have had to resort to operations under narcosis in order to stretch contractions, but these instances usually have been in neglected or late cases. Massage and exercises were begun as early as possible, in some instances even when the wounds were still open. We cite a few illustrative cases:



FIG. 10.—Case VI. January 6, 1919. Photograph taken before orthopædic treatments were started. Note the flexion of the hip and knees.

CASE I.—Becky S., aged four years, second degree burns of both feet from the perineum down to the knees. Admitted to the hospital June, 1919. Orthopædic treatments begun two weeks after the accident. Perfect recovery.

CASE II.—Abraham R., aged twelve years, burn affecting the left upper extremity from shoulder to elbow. Hand tied to the head of the bed on the second day. Later on a brace used. At present can abduct arm and rotate it freely. He is still wearing the brace. Scars are not stiff (see Figs. 5, 6, 7, 8 and 9).

CASE III.—Vera T., aged seven years, both hands and elbows burned. Second degree burn. Cured in three weeks.

CASE IV.—Israel W., aged eleven years, burn of left shoulder. Discharged wearing a Jones shoulder brace. Shoulder could be abducted to an angle of 110 degrees. Since discharge from the hospital, has not returned for reexamination.

CASE V.—Genevieve D., aged nine years, burns of right side of neck, two weeks prior to admission to hospital. Collar applied on November 15, 1919. Cured in three weeks.

CASE VI.—Anthony D., aged eight years. This is not a case of early orthopædic treatments, but of late application of these methods. Patient sustained a burn of right leg and treated for one year. When admitted to Fordham Hospital had contractions of hip on abdomen at an



FIG. 11.—Case VI. Photograph taken in February, 1920. Note the good position of the hips and the slightly flexed knee.



FIG. 12.—Case VI. Photograph taken in February, 1920. Note the shortening of the limb, probably increased by the presence of bone atrophy due to the flexed position in which the limb was kept before orthopædic treatments were instituted.

acute angle, knee flexed on thigh at an angle of 70 degrees, and leg almost dislocated. Some wounds in the back still open, and not covered with epithelium (see Fig. 10).

Operated on January 21, 1919, when the scar tissue of the popliteal fossa was excised and leg brought down to an angle of 160 degrees. We might have been able to stretch it more, but we feared rupture of the popliteal artery which was probably shorter than normal. The wound healed three months later. Of course, a brace was kept on the knee to prevent recontraction. The hip was operated on May 8, 1919, and the thigh brought down to an angle of 150 degrees, and a brace applied. On June 20, 1919, the brace was changed to a "walking brace," and a raised shoe made and patient encouraged to walk.

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FIG. 13.—Case VI. Lateral view of Case VI. February, 1920.



FIG. 14.—Case VII. Note the ability to separate the fingers and the good position of the little finger.

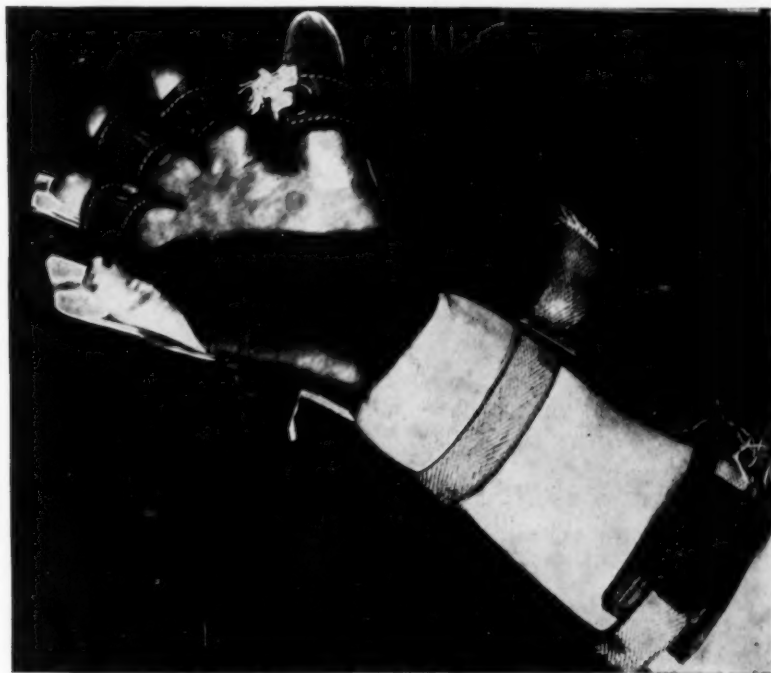


FIG. 15.—Case VII. The brace used to hold the fingers.

Examination February, 1920, shows: Thigh flexed at angle of 170 degrees. Knee in good position (Figs. 11, 12 and 13). We intend, however, to operate on him again and gain a better position for the hip.

CASE VII.—Leonard W. Burn of right hand resulted in marked contraction of little and ring fingers and palmar fascia and webbing of the little and ring fingers. Operated on June 7, 1918, the webbing corrected, the palmar fascia excised, and the little finger corrected. There was decided improvement in the palm and in time complete cure. The webbing has been cured, but the contraction of the little finger has recurred. It was very hard to hold it in the brace (Figs. 14 and 15).

These two last cases show the bad consequences of burns and the improvements that can be obtained by orthopædic methods.

CONCLUSIONS

1. Contractures of burns can easily be prevented by early orthopædic treatment.
2. By using simple methods, such as tying the limbs in positions to prevent contractures, no deformities develop and early recovery is obtained.
3. Holding the limbs in proper position accelerates the healing of the wounds.
4. Early massage, exercises, and the wearing of braces aid in obtaining satisfactory positions and proper use of the limbs.

We express our sincere thanks to Dr. Alexander Nicoll, the Director of the Service, for permission to make full use of the material. We wish to thank Mr. Morrison, photographer of the Bellevue and Allied Hospitals, for his coöperation.

TRANSACTIONS
OF THE
PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting held May 10, 1920

The President, DR. GEORGE G. ROSS, in the Chair

DISLOCATION OF THE SHOULDER AND FRACTURE OF THE SURGICAL NECK OF THE SCAPULA, CAUSED BY MUSCULAR ACTION DUE TO ELECTRIC SHOCK

DR. GEORGE M. LAWS exhibited a man of twenty-eight years, with no history of previous fracture except fractured ribs from adequate trauma, who, in the early days of his experience as an X-ray operator four and a half weeks ago, received a shock in this manner. His hands were outstretched so that they were a few inches from the wires and happened to be cold and wet. The current entered his left hand, passed across his body and out his right hand, holding both of them in contact with the wires. The left upper extremity was fully extended, forward and horizontal, and in order to break the circuit he pulled it downward and backward with all his strength. Suspecting a dislocation of the shoulder from his symptoms he made a film which confirmed it, and then went to his physician who reduced it, whereupon he went back and made another film. A few days later the physician brought him to me to clear up some doubtful features of the case. He then presented the signs of a minor injury at the acromio-clavicular joint and a fracture of the surgical neck of the scapula which was better shown by subsequent radiograms. Union is not yet firm and tenderness persists at the suprascapular notch and at the site of fracture on the axillary border. Incidentally he received a burn on each hand.

DR. T. TURNER THOMAS said that he had never recognized a case of fracture of the surgical neck of the scapula. The X-rays in this case are a little bit vague, but show clearly damage done to the glenoid process. He had seen in a number of cases operated on for recurrent dislocation of the shoulder more or less of the anterior part of the glenoid process broken off. He recalled one case where the glenoid process was broken in half; the anterior part being entirely separated from the scapula and the posterior part being continuous with the scapula.

PYOCOLPOS AND PYOMETRA IN A CHILD AGED SIXTEEN MONTHS

DR. DAMON B. PFEIFFER reported the case of a female child aged sixteen months who was admitted on February 4, 1920, to the service of Dr. J. P. Crozer Griffith in the Hospital of the University of Pennsylvania.

The chief complaints were retention of urine and fever. The patient was one of twin girls normally born. Both were bottle-fed, and had been pale and rather delicate, but had had no serious illnesses. This child had always been constipated. The father, mother, and two older sisters were living and well. The child was in her usual health until about ten days before admission, when she became fretful and feverish. The mother noticed that she strained as if in pain and passed no urine. The family physician was called and he removed ten ounces of urine by catheter. Since that time she has required catheterization four times daily. On questioning, however, the mother stated that the child had been "always wet" before the onset of the present illness. On admission the temperature was 103° F., pulse 128, and respirations 28 per minute. The temperature remained high with moderate variations throughout the course of the illness.

The child weighed 19 pounds and was rather fat, but presented an unhealthy, yellowish pallor. She was feverish, fretful, and uneasy. The head, neck, and chest were negative except for slight evidences of rickets. The abdomen was tense and much distended. Above the umbilicus the abdomen was tympanitic. Below the umbilicus there was dulness over an oval area corresponding to the position which would be occupied by an enormously distended bladder. Here a firm, somewhat resilient mass could be felt rising from beneath the symphysis. It was smooth except at the summit, where a definite nodule was palpable. There was no evidence of free fluid within the abdomen. There was tenderness in the right loin posteriorly. Catheterization obtained 12 ounces of urine of specific gravity 1006, acid in reaction, showing a trace of albumin and much pus, otherwise negative. After catheterization the mass previously felt was slightly smaller but otherwise unchanged in character. Rectal examination revealed a mass filling the cul-de-sac anteriorly which was similar in character and evidently continuous with the suprapubic mass. The vaginal outlet was normal in appearance. It seemed to have a lumen, did not bulge, and no attempt was made to examine vaginally. It was the consensus of opinion that the mass was a tumor, probably of embryonic sarcomatous character and inoperable. On the day after admission the blood examination was as follows: Hæmoglobin, 21 per cent.; red blood-cells, 2,930,000; white blood-cells, 23,800; polynuclears, 80 per cent.; lymphocytes, 16 per cent.; mononuclears, 2 per cent.; transitionals, 2 per cent.

The course was down grade. On the ninth marked venous stasis appeared in the left leg. Radiographic examination was inconclusive but suggested to Doctor Pancoast that the mass was cystic. On the following day, thinking that it might be possible to drain a suppurative cystic collection with a minimum of time and trauma, for it was apparent that the child was almost moribund, under light ether anaesthesia the abdomen was opened over the mass, which was at once perceived to be cystic. On the summit the uterus and adnexa were perched, normal in appearance

RETAINED DRAINAGE TUBE FOLLOWING CHOLECYSTOTOMY

except for distention of the uterus to about 4 cm. in length and 3 cm. in width at the fundus. Recognizing the condition as cystic dilatation of the vagina and uterus, the wound was covered and the vagina dilated. Just within the vestibule was an imperforate septum which was punctured with immediate discharge of about a litre of watery, yellowish pus. Unfortunately, at this stage the child ceased to breathe and died in spite of attempts at resuscitation.

An immediate post-mortem examination showed marked bilateral pyonephrosis and pyoureter. The anatomical conditions and relations suggested that the cavity of the vagina had become infected by direct extension from the lower end of the infected ureters, though it can not be denied that the pyocolpos may have preceded the urinary infection which would then have been favored by pressure and stasis.

RETAINED DRAINAGE TUBE FOLLOWING CHOLECYSTOTOMY

DR. MORRIS BOOTH MILLER reported the following case as worthy of note as an unusual accidental sequel of cholecystotomy. Incidentally it furnishes an additional though rare argument in favor of cholecystectomy in gall-bladder disease. It further carries a lesson to the hospital interne who was probably responsible for the mishap which required reoperation eight years later.

T. F., aged fifty years, a native of Poland, was admitted to the Medico-Chirurgical Hospital on March 18, 1920, with chief complaint of pain in the right epigastrium. As he could only speak Polish a history was obtained through an interpreter and this at its best was inexplicit and unsatisfactory. As nearly as could be learned he had been troubled with pain in the epigastrium since the age of thirteen. He was operated on in Troy, N. Y., eight years ago for this pain and was somewhat improved but not entirely relieved. As to the after-treatment he states that "a large tube was in his side and that when this came out a smaller one was put in." He seemed totally ignorant of the cause which led to the second operation, and naturally and for obvious reasons, he has not been enlightened. Two years ago he commenced to have pains in the upper abdomen resembling sticking of pins; sometimes the pains radiated to the back or right side; no vomiting at any time, but has had occasional periods of nausea; no noticeable loss of weight; has been generally constipated. No history of colic.

Physical examination revealed practically no phenomena of importance. Heart and lungs were normal, no enlargement of spleen or liver. There was a scar over the right rectus commencing at the costal margin running straight downwards for about 10 centimetres. Abdomen soft with no distention, and the only unusual feature which was noticed was slight rigidity over a small area about the upper portion of the scar. Even this was apparently voluntary and thought to be associated with the place where he felt the pain. He breathed freely without increase of pain.

There was no jaundice. The urine reports showed nothing suggestive and gastric analysis gave no material departure from the normal. Blood examination showed a small increase in leucocytes to 8700, dropping in two days to 6500, but otherwise negative. As he was entirely afebrile he was kept under observation as a probable mild case of cholecystitis, possibly due to stone formation. Further investigation, however, with the aid of the X-ray, revealed the cause beyond a question of doubt, as the shadow of a piece of drainage tube was distinctly shown lying transversely below the liver.

Incision through the right rectus revealed many adhesions between the parietes, stomach, duodenum, and liver. Patient dissection exposed the fundus of the gall-bladder lying well under the liver, less than half its normal size, with moderately thickened walls and densely bound down by adhesions. The fundus was probably 8 or 10 centimetres from the surface of the abdomen. Upon opening it a small quantity of foul-smelling bile escaped, and at once a piece of drainage tube 8 centimetres long was picked out. Apparently the gall-bladder had shrunk down until it represented an approximate sheath for the tube. No adventitious stones were found, but one end of the tube was filled with stone formation making a partial cast of the tube. An attempt to do a cholecystectomy was only partially successful as the difficulties of the dissection, as well as the impossibility of identifying relationships, made it necessary to leave a more substantial stump than otherwise would have been done, and even then it was necessary to leave an angled clamp on the stump for seventy-two hours. Recovery was smooth and uneventful.

The probable explanation of this mishap is very simple. When the original drainage tube came away a tube of shorter length and likely lesser calibre was inserted into the drainage track without safety pin or other guard. This shorter tube slipped down the track until it came to rest at the lower end of the gall-bladder, and in course of time the drainage track closed above it. Whether the disappearance of the tube was carelessly explained at the time by being lost in the dressings, or whether the interne or surgeon did have some qualms of misgiving is a matter of interesting speculation.

The reporter had not been able to make a search for similar cases in the literature. For obvious reasons, if they exist in any numbers, they are not apt to be dwelt upon except perchance by the lawyers. He had, however, had his attention called to a case recently reported by Arthur Dean Bevan in the *Surgical Clinics of Chicago* for February, 1920, in which a gauze sponge was removed from a gall-bladder eleven years after the original operation. In this case operation was performed for supposed malignancy which the physical findings seemed to indicate. It is furthermore interesting in that the meshes of the gauze sponge furnished a nidus for stone formation, so that when removed it had the form of a cast of the entire gall-bladder.

STRANGULATED EPIGASTRIC HERNIA

STRANGULATED EPIGASTRIC HERNIA

DR. CALVIN M. SMYTH, JR., said that by epigastric hernia was to be understood any hernia through the linea alba, or sheath of the rectus, between the ensiform and the umbilicus. Epigastric hernia is not common, and strangulation of such herniæ is exceedingly rare. Four types of epigastric hernia are recognized: (1) There is a protrusion of preperitoneal fat through a slit in the linea alba. This is not a true hernia in the stricter sense. (2) In addition to the preperitoneal fat, there is a process of peritoneum protruded, thus forming a sac. The sac, however, is without contents. (3) The sac contains all or a part of the great omentum. (4) Both omentum and gut are protruded.

The last type is the rarest and the one less frequently operated upon. This is due in part to the fact that patients suffering from this variety of hernia do not so frequently present themselves for treatment, because they suffer little or no pain. This is in contradistinction to the other types which give severe pain noted by Moschovitz. In reviewing the literature he had found only about fourteen cases of strangulated epigastric hernia on record, and in only five of these did the hernia contain gut. The most recent of these cases was reported by Gatewood in 1910. In his report he states that only four such cases were on record prior to his. To the best of our knowledge the subject of this report is the sixth one.

The explanation, or at least one explanation of the rarity of this condition, may be found in a consideration of the anatomical factors present. The linea alba is a very strong structure composed of dense fibrous connective tissue, the fibres running in three directions. The transverse fibres are the coarsest and the strongest, therefore, most of the defects are in this direction. Another fact to be borne in mind is the tension of the peritoneum in this region in contrast to the comparative flaccidity of the lower abdominal peritoneum. Then, too, the epigastric viscera are of a size which makes herniation unlikely; for example, a defect which would permit of the protrusion of a loop of small gut would not be large enough to allow a loop of transverse colon to escape from the abdominal cavity. Transverse colon is nearly always the portion of the gut that is encountered in these cases. The rarity of this condition would seem to warrant the report of one more case.

The case reported by Doctor Smyth was as follows: A white woman, aged sixty-eight years, para 6, weighs 268 pounds, was admitted to the service of Dr. G. G. Ross at the Methodist Hospital, December 19, 1919, with the chief complaint pain in the abdomen and vomiting.

For the past eight years she has had a mass in the abdominal wall, above the umbilicus. For the past four years it has been gradually increasing in size, and during this period she has worn a combination truss and abdominal binder. The mass always became prominent at night and it has been her custom to replace it each morning on arising. She

has never had any difficulty in accomplishing this until the morning of her admission to the hospital. This morning she was unable to reduce it and sent for her doctor. About half an hour after rising she was seized with a sharp stabbing pain in the epigastrium. The pain was somewhat relieved by vomiting, which she induced. The relief, however, was only temporary, and in the course of the next three or four hours she vomited eight times. The pain became steadily worse. Her physician then ordered her removal to the hospital. No attempt at reduction had been made prior to her admission.

On admission the patient was in a state of exhaustion, although she was not suffering much pain. A mass about the size of a small grapefruit was felt in the epigastric region about four inches above the umbilicus. It projected far out to the right and was hard and immovable. The percussion note was dull. Auscultation of the abdomen disclosed markedly exaggerated peristalsis, and there was a slight distention of the abdomen. An enema which was given proved very slightly effectual.

Operation.—Under ether the abdomen was opened in the midline and the hernial sac was located without difficulty and incised. The opening of the sac was followed immediately by a gush of clear straw-colored fluid amounting to about 250 c.c. The omentum, which had evidently been present in the hernia for some time, was in an advanced state of degeneration. It was adherent to the sac and was freed with considerable difficulty. A loop of transverse colon about five inches long then presented itself, and following this down with the finger, the opening through which the hernia had occurred was located. This opening was found to be a transverse slit in the linea alba which would not admit two fingers. A grooved director was passed into the opening and it was enlarged by cutting upward. The gut was discolored but still retained its resilience, and after the constriction was relieved soon returned to the normal. The gut was then returned to the abdomen and the degenerated omentum excised. The sac was treated in the usual manner. The anterior sheath of the rectus was then dissected up on either side of the opening and for about three inches in the longitudinal direction. The flaps thus made were overlapped and secured by several interrupted mattress sutures. The rest of the wound was closed in the ordinary manner. Uneventful recovery. She was discharged from the hospital on the twenty-first day after operation, and when last heard from was in perfect health. There has been no recurrence of the hernia.

DR. MORRIS BOOTH MILLER said that for many years he had, midway between the umbilicus and the ensiform, a little flat tumor about the size of a 25-cent piece which he could feel through the tissues, but which had never given him any direct trouble. Although for some of these years he had digestive trouble, which some of his friends thought was due to duodenal ulcer, this condition was never definitely diagnosed. During the late winter of 1917-1918 while serving on the United

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States ship *President Grant*, they were subjected to severe weather and considerable exposure on the east bound voyage. During the latter part of that trip he caught a bad cold which terminated in cough. The night after Brest was reached he had an attack of coughing which kept him awake. During the night he was taken with an especially severe paroxysm, during which he felt something in his upper abdomen give way, and noticed that the little flat tumor had grown to the size of an egg. He did not vomit, although he had some nausea, but the tumor was so painful that he could not stand erect. The next morning he was sent to Naval Hospital No. 5 where he saw Doctor LeConte and Doctor Ross. The diagnosis was an incarcerated epigastric hernia, and operation was advised. He returned to the United States and was operated upon at the Naval Hospital, Philadelphia. Dr. W. A. Angwin, the operator, stated that on opening the abdomen he found a small sac which had omentum in it which showed evidences of recent inflammation. The opening in the linea alba was the size of a lead pencil. Uneventful recovery.

THE SURGICAL TREATMENT OF BURNS

DR. W. ESTELL LEE read a paper with the above title.

DR. HUBLEY R. OWEN said that he had under his care at the present time a child who, three weeks ago, while melting paraffine, set fire to her clothing and she was badly burned. Her burns would undoubtedly have been much more serious had she not had the presence of mind to fall on the floor and wrap herself in a rug. Her burns extended from above her ankles to her groins anteriorly, and from above her ankles to above her buttocks posteriorly. He saw her four or five hours after she had been burned. In the emergency her father had covered the whole burned area with picric acid, and applied it very freely. This picric acid dressing was removed at the first visit and boric acid ointment applied. In spite of the fact that the picric acid had been applied to the burn only a few hours, she developed symptoms of absorption of picric acid the following day.

Amberine was used for a few days until sloughing developed. It was then discontinued and Dakin's solution applied over the burned area. Dakin's solution was somewhat painful, but cleared the burn up wonderfully. Her kidneys were in good condition, and, under light anæsthesia, the sloughs were cut away. Hypertonic salt solution was tried, but this was very painful and had to be discarded.

He believed the whole secret in the treatment of a burn is cleanliness—not only keeping the burned area surgically clean by removing sloughs, but also keeping the surrounding skin clean. This cleansing is best accomplished under an anæsthetic.

One of the worst burns he had ever had occasion to treat was in the person of a child, in the service of Doctor Wharton at the Children's Hospital, many years ago. She was burned around her abdomen, vagina, thighs, and buttocks. In the treatment of that child a cradle was used to

hold the bedclothes away from the burned area, and an electric light was placed under this cradle to keep the child warm, and keep the burn surgically clean. Of course, at that time Dakin's solution had not yet been devised, but in that case salt solution was used.

DR. GEORGE P. MULLER said a good many burns are admitted to his service at the St. Agnes and Polyclinic Hospitals. In association with his assistant, Doctor Ryan, he had tried to reduce the mortality and to improve the methods of external dressing. To understand the phenomena of burns one must consider three factors, namely, shock, toxæmia, and infection. Therefore, from the moment of admission to the hospital the patient, usually a child, must be considered as in a state of shock or on the verge of it. Too often they remain in the receiving wards, which are usually cold and draughty and noisy, to have a preliminary dressing applied before admission to the wards. He tried to have a blanket thrown over the patient and an immediate admission made. The patient's clothing should be rapidly cut away, the patient placed on a blanket and covered with some form of frame for holding electric light, over which another blanket can be thrown. When the electric lights are turned on the body is in a warm chamber, the temperature of which can be regulated at will. The foot of the bed should be elevated, moderate doses of morphine given, and a continuous enteroclysis of salt solution started. Hot drinks and the other accessories useful in shock are added.

Many terribly burned cases come out of shock nicely but die a few days later with manifestations of intense toxæmia. Some have lived several weeks and then died, even though the external surface was clean. They had pushed water to the utmost and had used sodium bicarbonate a good deal, intravenously and by the mouth, but it would seem as though the patients became sensitized and then succumbed from further absorptions of the poison.

To control the infection they had in the last year routinely used dichloramine-T, sprayed upon the burned surface every six hours at first and later every twelve hours. He did not find it hurt the patient after the first spraying if the oil is perfectly fresh. If it smells acrid it should be discarded. Some cases crust up too much and wet dressings are useful for a time. In such cases he protected the surface with paraffine mesh, but had stopped entirely the paraffine film method. One gets just as good results from the perforated mesh and a great deal of time is saved. If an occlusive dressing is needed adhesive strapping is as good as the paraffine film. Fortunately, male adults are usually burned on the hands, face, and neck. There is no difficulty keeping women and children extensively burned on the entire body and trunk under the frame and with no covering.

Therefore, he believed that if the shock is controlled and if attention is paid from the very beginning to the nature of infection, practically all burned cases do well except the hyperacute toxic cases who die appar-

THE SURGICAL TREATMENT OF BURNS

ently for no reason at all. Some German writers have advocated removal of the entire burned area by curettage, but it seemed to him that the trauma and the hemorrhage would offset the advantages.

DR. JOHN H. JOPSON said there is one effect of amberine which he had observed and after no other dressing, and that is very rapid epithelialization over the whole surface. He recalled one man who suffered a typical airman's burn over the surface of his face which was unprotected by his helmet. He was dressed with amberine from the start, and the spread of skin over the surface was very different from that observed ordinarily. Each day it was as if one had used a powder shaker over it. These epithelial cells must have been partially undestroyed, but the protection afforded by the amberine had prevented their being washed off. I think Doctor Lee's contribution is a notable one on sterilization. It would be interesting in these cases to plot out the rate of healing by Doctor Macy's method. Fauntleroy in his paper reporting a large series of burns discusses the value of occasional change of character of dressing, which he calls "switching time." In other words, if we treat these cases by any one antiseptic we find that the granulating surface becomes habituated to that type of dressing and healing slows up. We have seen this exemplified in the sterilization of other types of wounds.

DR. GEORGE G. ROSS said that he had an unusual opportunity of observing cases treated by dichloramine-T in the service in France. He was impressed by observing what Doctor Jopson noticed, the islands of epithelial cells growing widely over the granulating surface, as if thrown on by a pepper box; healing was much more prompt and the scars better. A great many burn cases came into the hospital at Brest. He remembered on one occasion an ammunition ship was blown up and sixteen men were brought in, four died immediately. On another occasion six or seven were brought in and they had two to sixteen or twenty men real badly burned all the time. They tried out every known method of treatment and finally came to the conclusion that wide mesh paraffine gauze with dichloramine-T was the most comfortable and easiest method by which a burn could be easily sterilized and unquestionably gave the best type of scar.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting held May 12, 1920

The President, DR. WILLIAM A. DOWNES, in the Chair

USE OF CHINOSOL AND SODIUM CHLORIDE IN THE TREATMENT OF WOUNDS

DR. WILLIAM C. LUSK read a paper with the above title.

DR. ROBERT T. MORRIS stated that the addition of salt to chinosol would offer a great advantage. He had been using chinosol for many years, and it seemed to him that the addition of salt introduced an improvement which should be recognized more often than it was in mixing antiseptic solutions generally, for the reason that ordinary water was distinctly corrosive in its action. This was because of the exosmosis which took the salts out of the protecting tissue-cells and lowered their efficiency. This action could be demonstrated by comparing the action of plain water with that of an isotonic salt solution on the tail of a rat if one was studying the tail tendons. They are dulled at once in plain water, but remained glistening in saline solution. This principle had not been applied enough in eye work. It was important to make up lotions with a salt solution that was isotonic, because a solution that was not isotonic for blood-serum exerted a corrosive influence on account of the laws of osmosis.

RECURRENT FIBROSARCOMA OF SKIN

(Fifteen years after the original operation)

DR. H. H. M. LYLE presented a man who, twenty years ago, first noticed a pedunculated wart in the region of the left shoulder. Five years later this wart began to show evidences of ulceration which led him to consult Doctor Abbe, who made a diagnosis of sarcoma and removed the growth with an extensive area of skin. A small recurrence one year later necessitated a secondary operation. Since this time the man had remained in perfect health, without signs of recurrence for fourteen years. A short time before entrance to St. Luke's Hospital the patient noticed a soft, flat growth in the middle of the old scar. Physical examination showed a cicatrix 6 by 4 inches on the left base of neck and shoulder. This area had been grafted at the previous operation fifteen years ago. The grafted

ANGIO-KERATOMA OF SCROTUM

area extended from the border of the trapezius over the shoulder anteriorly to the second rib. Just posterior to the middle third of the clavicle was a round, raised, adherent mass 2 inches in diameter. The mass was red and was crossed by numerous dilated veins. No axillary or cervical glands were palpated. X-ray examination of bones and chest was negative.

On July 2, 1919, the area of old skin graft was excised and the tumor removed *en masse* along with deep fascia covering the upper part of the deltoid. The superficial portions of the pectoralis major and trapezius that were in relation to the old skin graft were also removed. The resulting raw surface was covered by skin grafts taken from the thigh.

The pathological diagnosis was fibrosarcoma of skin (recurrent).

ANGIO-KERATOMA OF SCROTUM

DOCTOR LYLE presented a man who was admitted to St. Luke's Hospital with a diagnosis of a left-side varicocele. Six years before he had suffered from a swelling of the scrotum which he attributed to a number of minute blood blisters. These so-called blood blisters had broken at times and bled profusely. He now came to the hospital to see if a varicocele operation would help the condition.

There was a moderate varicocele of the left cord. Numerous small, raised, purplish-red nodules were scattered over the scrotum. These nodules were firm, and appeared to be in relation to the finer blood-vessels of the scrotum. There was an extensive port-wine naevus on the left arm and shoulder. The patient was referred to the Dermatological Clinic for the condition.

A portion of tissue was removed and a diagnosis of angio-keratoma made. The patient was then referred back to the surgical service for an operation on the varicocele, with the idea of lessening the congestion in the veins of the scrotum. This had improved, but not cured the condition.

DR. DE WITT STETTEN said as to this case of angio-keratoma of the scrotum that he had at present under treatment an almost identical case. The patient complained that he had multiple bleeding points on the scrotum, which on examination appeared to be angiomatous warts. The condition was mainly unilateral, in this instance, right-sided. The growths, however, were somewhat larger and the slightest irritation caused profuse hemorrhage. Under local anæsthesia Doctor Stetten excised these warts individually, removing some twenty odd at one sitting. He was much gratified to find, when the wounds had healed, that the skin of the scrotum looked practically normal. There was a large branching varicose vein at the perineal junction of the scrotum, which was apparently a tributary of the right superficial perineal vein and was probably related to the angiomatous condition. Doctor Stetten said he intended to excise this vein before he discharged the patient. He did not believe the spermatic veins had anything to do with the disease because the lesion was a super-

ficial, cutaneous one and on the side opposite the varicocele. Neither did he think a varicocele operation would affect it at all.

ANKYLOSIS OF THE TEMPORO-MAXILLARY ARTICULATION

DR. JOHN DOUGLAS presented a boy, five years of age, who was admitted to St. Luke's Hospital June 6, 1919. He began to have difficulty in opening his mouth two years previously, but no previous history of otitis media or of an acute illness could be obtained which would furnish a cause for the temporo-maxillary ankylosis. His trouble progressed until at the time of admission he could only separate his incisor teeth 0.5 of a centimetre. There was no rotary motion. A slight deviation of the chin toward the left side was present.

At operation it was found that there was a complete bony ankylosis of the left temporo-maxillary joint, the production of new bone extending to and fusing with the posterior part of the zygoma. A horizontal incision was made just above the zygoma, its posterior end being extended upward 1.5 centimetres. The articular process and the neck of the mandible was removed with a chisel and the new bone extending to the zygoma and into the articular fossa excised, whereupon the lower jaw opened easily, showing that the other side was not involved; a flap of the temporal fascia with the overlying fat was dissected, its base being along the zygoma. This was turned down and fastened into the articular fossa. There was no injury to the facial nerve and the final result as now shown was excellent, although it was impossible to get the parents of the child to carry out any after-treatment to keep up complete motion in the joint.

DR. GEORGE WOOLSEY said he had had a somewhat similar case some years ago in a woman physician. She had fallen when a child and had never since that time been able to take anything but liquid food. He found an ankylosis of the left temporo-maxillary articulation upon which he operated by resection and turning in of a flap of temporal fascia, and obtained a very good result. He kept the jaws apart for some time after the operation. He thought it was an advantage to do the operation early in life because the jaw then had an opportunity to develop. This woman had a very poor development of the lower jaw. He thought the development would have been much better had she been operated upon earlier in life.

DR. A. O. WHIPPLE asked Doctor Douglas why he used the fascial transplant; whether it was to prevent ankylosis occurring again.

DOCTOR DOUGLAS replied that the condyle of the inferior maxillary was excised and this left a raw surface on this bone and there was also a raw surface on the temporal portion of the articulation. A fascial transplant introduced between these raw surfaces prevented recurrence of the ankylosis due to production of new bone which might occur unless some material was interposed. It was essential to remove enough bone not to cause pressure on the interposed flap.

PLASTIC ON THE FACE BY THE TUBULAR FLAP METHOD

PLASTIC ON THE FACE BY THE TUBULAR FLAP METHOD

DR. JOHN DOUGLAS presented a woman, seventy-five years of age, who had a small epithelioma just under the inner portion of the left eye which had been slowly increasing in size for four years. During eight or nine months previous to the time when she was first seen by him, she had been treated with the X-ray and radium. This finally resulted in the skin area healing over, but at the expense of the tissue of the side of the face, so that the contraction of the scar tissue had caused the right nostril to be pulled up and the inner canthus of the eye to be pulled down.

The area had remained healed for only one week when it had broken open again and she was referred to him by the physician from whom she was receiving her radiograph treatment. At this time she had a small ulcer in the area described, through which a probe could be introduced into the antrum of Highmore, a portion of the anterior wall having been destroyed by the growth. In August, 1919, the epithelioma, which was of the basal type, was excised, together with a considerable portion of the anterior wall of the antrum, an opening being made into the nasal cavity to thoroughly drain the antrum. The wound was closed by a sliding flap from the lower part of the face. In performing the plastic operation, it was impossible to lift the inner canthus of the eye without injuring the lachrymal duct, so this was not attempted.

Six months later a small recurrence appeared on the side of the nose. This was evidently deep in its origin as the squamous layer of epithelium was not involved. It was, therefore, necessary to do a deep excision which could not be covered by a skin graft. The loose skin on the side of the face had been utilized for the previous plastic operation. The use of a sliding flap from the forehead would probably have caused considerable deformity, and therefore it was determined to use the tubular flap method of Gillies. The patient had a large goitre with considerable loose skin on the neck. On March 8, 1920, under local anæsthesia, two parallel incisions about four centimetres apart were made in the neck, making a flap about sixteen centimetres long. The flap was dissected up, and the skin edges sutured together, making the tube of skin and subcutaneous tissue which was left attached at both ends.

The skin edges were freed and sutured together underneath the flap, closing the raw area, from which the flap had been removed. Twelve days later, there being a good circulation in the flap, again under local anæsthesia, an area at the left end of the flap was cut out in the skin, which after allowing for shrinkage, would be sufficiently large to fill in the area it was determined to excise from the side of the nose. This was only partly cut away from its deep attachment and left attached to the end of the flap for the further development of collateral circulation from what was to be the base of the tubular flap at the right end. This was loosened a little further each day, and on the third day, under ether anæsthesia, a

deep excision of the carcinomatous area involved was done. It was necessary to excise the periosteum over the right nasal bone and the nasal process of the superior maxilla, and also a small portion of the nasal mucous membrane. The flap was then sutured into place to close this defect. One week later the flap, having become adherent and well healed to the skin edges of the new area, it was cut off close to the face and the edge sutured to the cheek and the base end cut off; the wound in the neck from which it took its origin was closed. Doctor Douglas said the patient was shown as an example of the use of the tubular-flap method in plastic surgery of the face.

JEJUNAL ULCER FOLLOWING GASTRO-ENTEROSTOMY

DR. JOHN DOUGLAS presented a man, thirty-one years of age, who was admitted to St. Luke's Hospital January 23, 1920. He began to have severe abdominal pain ten years previously. At this time had repeated vomiting attacks during which he vomited a large amount of blood and had blood in the stools. Shortly afterward he had a gastro-enterostomy done in a Brooklyn hospital for "ulcer of the stomach." He was relieved of pain for one year after operation while he remained on a diet, and then as he returned to a regular diet pain returned and has persisted. Pain had been more severe than at first; it was relieved by food for an hour or two or by eructation of gas, was worse always at midnight, and was increased by sweet food.

Two years ago he had a severe attack of vomiting of blood accompanied by syncope. Three years ago and again two years ago he entered different hospitals where, after radiograph examination of the stomach, he was discharged without treatment. For the past week has vomited frequently large amounts without blood or nausea, always after meals. There had been no blood in the stools. Physical examination showed the urine and blood-pressure all negative, and a radiographic examination showed nothing diagnostic.

At operation a number of adhesions between the first portion of the duodenum and liver were found which would suggest an old healed duodenal ulcer. There was no induration of the duodenum suggestive of active ulcer, and no narrowing of the pylorus was present. The gastro-jejuno-stoma was at the junction of the horizontal and vertical portions of the stomach and admitted three fingers; there was no thickening about its margin to suggest a gastro-jejunal ulcer. The anastomosis was of the short loop, isoperistaltic type.

On separating the stomach and intestine, a small punched-out ulcer about .5 cm. in diameter with thickened base and edges was found on the jejunal wall about .5 cm. proximal to the anastomosis. This ulcer was excised, and as there was no evidence of active ulcer present, the openings in the stomach and the intestine were closed by chromic catgut suture.

JEJUNAL ULCER FOLLOWING GASTRO-ENTEROSTOMY

The specimen showed a piece of linen thread in the serous coat, but not apparently entering into the base or edges of the ulcer.

The patient was relieved of his symptoms entirely for about two months, but recently has again suffered from epigastric discomfort. A recent radiograph shows that the stomach empties in four hours, and a test meal shows marked hyperacidity, and his further treatment has been directed to the relief of this hyperacidity.

DR. ROBERT T. MORRIS asked Doctor Douglas if he had looked up the question of elective affinity. It had been shown that certain infective agents had an elective affinity for this location, and they called out abnormal hormones followed by hyperacidity often. Antibodies also were called out to combat the toxins, and these in excess causing autolysis, might be a factor in the recurrence of ulcer. Another question was whether there was an excess of carbohydrate fermentation in the colon. Were any Welch bacilli found in the colon? Unless one took into consideration all these questions and worked them out and searched for all possible foci of infection, one was very likely to have a recurrence of ulcer at any time because the same conditions which produced the first ulcer were still in existence.

DR. A. V. MOSCHCOWITZ asked what was the location of this ulcer? Then there was some question about a linen thread in the ulcer. Was this thread in the centre of the ulcer? Also, did Doctor Douglas use linen sutures?

In answer to questions Doctor Douglas said he found the linen thread in the edge of the ulcer, not the base. It appeared as though it might have been an interrupted stitch in the serous coat. The ulcer was about one-half a centimetre away from the gastro-enterostomy. It was a jejunal, not a gastro-jejunal ulcer, as usually occurred, and was on the proximal, not on the distal side of the stoma. A supposed etiological factor in the development of jejunal ulcer was the pouring out of the acid stomach contents into the jejunum which was normally accustomed to an alkaline reaction, but in this case, as has been frequently reported in the literature, the presence of a linen suture seemed to have been a determining cause. Doctor Douglas further stated, in answer to Doctor Moschcowitz, that he had used no linen or silk sutures in stomach operations for the past five or six years.

DOCTOR MOSCHCOWITZ said he was glad that this little thread was found in the ulcer, because he believed that most gastro-jejunal ulcers were due to the fact that linen thread was used. He had been guilty of its use himself, but he liked linen thread and found it a little difficult to break the habit of using it. However, he had made up his mind never to use silk or linen threads again in the stomach. It would be interesting to

know if there were any series of jejunal or gastro-jejunal ulcer cases in which chromicized catgut only had been used; he had never seen such.

MODIFIED TECHNIC FOR THE RADICAL CURE OF INGUINAL HERNIA

DR. DE WITT STETTEN, in connection with Doctor Hoguet's paper, presented some lantern slides to illustrate a modified Bassini-Andrews technic for hernioplasty, which he had been using for some time and which was particularly applicable for direct hernia. A detailed report of this procedure was published in the *ANNALS OF SURGERY*, June, 1920, p. 744.

He believed that it was generally conceded that any operation in which the cord was not transplanted was bad in direct hernia, and that, even in indirect cases, the percentage of recurrence was less with cord transplantation. In the typical Bassini operation the result hinges upon a frequently doubtful, solitary suture line of the internal oblique and conjoined tendon to Poupart's. In many cases this suture line was entirely inadequate. The aponeurosis of the external oblique was not used at all for the actual repair of the hernial defect, but was sutured over the cord as a superfluous covering. In the posterior Andrews and kindred modifications the upper flap of the external oblique aponeurosis was made use of and sutured to Poupart's over the Bassini suture. The lower flap was sewed over the cord where it accomplished little as far as the plastic was concerned, but tended rather to compress and angulate the cord.

The modification which Doctor Stetten had been using he said went a step further and utilized all the available material for the real hernioplasty. After the Bassini suture and the suture of the upper flap of the external oblique aponeurosis to Poupart's had been accomplished, the rather liberal lower flap was divided up to Poupart's with a scissors, perpendicularly to its fibres at a point opposite the ring. These two portions of the lower flap were now overlapped on and sutured directly to the upper flap. The cord emerged between the two portions of the lower flap, and the medial portion lay beneath the cord. The cord was left subcutaneous. This subcutaneous position of the cord, in my experience, had never been the source of any trouble.

The advantages of the proposed plan were:

First. A triple layer of tissue was used for the actual closure of the hernial orifice. The typical Bassini suture was reinforced by a double suture line overlapping the aponeurosis beneath the cord.

Second. Danger of kinking the cord was eliminated.

Third. Should there be oozing from the cord, the hæmatoma would be merely under the skin, instead of submuscular or subaponeurotic. It would be easily accessible and it would not interfere with the suture lines.

The method, Doctor Stetten felt, was particularly serviceable in direct and recurrent herniæ, especially in old, large, and difficult ones, in sliding herniæ, and in cases where the development of the internal oblique and

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conjoined tendon was poor and where Poupart's ligament was thin or tears easily.

In a fair-sized series of cases of almost every variety of inguinal hernia, he had, as yet, seen no recurrences in the cases which he had been able to follow up. Further, he had found the formation of a flap from the rectus muscle or the anterior rectus sheath unnecessary, even in the most unfavorable cases.

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DR. P. J. HOGUET read a paper with the above title.

DR. WM. A. DOWNES said the problem of inguinal hernia had resolved itself into the management of the direct variety. Many surgeons recognized the futility of the usual technic for indirect hernia when applied to the direct type, and various modifications of recognized procedures had been devised to correct the inherent anatomical defects which gave rise to this form of rupture. Up to the present time none of these modifications had proved satisfactory in all cases. The difficulty lay in selecting the cases suitable for operation, and he for one had reached the conclusion that a certain number of direct hernias could not be cured by operation. There was a small but definite group of patients, usually thin men with poorly-developed muscles in both lower quadrants, in whom it was not wise to operate for this condition, as recurrence was almost certain to follow. Therefore, the results obtained in the operative treatment of hernia depend in a large measure upon the selection of cases. Having decided that a case was suitable for operation the next step was the selection of the proper operation. If the muscles were well developed any one of the recognized procedures might give a perfect result. On the other hand, if the muscles were thinned out and poorly developed, and the sac large, its base extending almost from the epigastric artery to the pubic bone, an entirely different operation was necessary if a satisfactory outcome was to be expected. In 1909 Doctor Downes stated that he began the use of the transplanted, or, more properly speaking, transposed rectus muscle in conjunction with the Bassini operation in the treatment of this class of patients. So many recurrences were taking place in his patients as well as those of other surgeons with whom he was associated that it became quite evident that the Bassini operation alone did not meet the indications. He therefore adopted the following method which had been modified from time to time, and which he illustrated by lantern slides: The usual skin incision was made carrying the lower angle down to the pubic bone, the aponeurosis of the external oblique was divided well over towards the edge of the rectus muscle, and both flaps were retracted. The sharp edge of Poupart's ligament was then exposed down to the pubic spine. By blunt dissection the fibres of the cremaster muscle were separated and the cord gently lifted from its bed. A small retractor was now placed under the arched fibres of the internal oblique and trans-

versalis exposing the internal ring. By gentle traction on the cord the peritoneal reflection at the internal ring was brought into view and the presence or absence of an oblique hernia quickly determined. This step was absolutely essential and should be carried out before attempting to isolate the direct hernial sac, irrespective of its size or location, for in no other way could the error of overlooking the indirect portion of a combined sac be avoided. Personally, Doctor Downes said he believed the sac should be opened in every hernia that was of sufficient size to warrant operation. With the finger inserted through the neck of the sac for support the fat was gently stripped from its surface, and if the obliterated hypogastric artery interfered with proper dissection it should be cut. After the sac wall had been satisfactorily exposed, its base should be drawn flush with the opening in the fascia and transfixed, or, better still, if of large size sutured in the manner of closing the peritoneum in laparotomy wounds. For this purpose he used No. 1 chromicized catgut. In the cases of combined direct and indirect hernia the two portions of the sac should be converted into one, by drawing one or the other above or below the deep epigastric artery, being guided by their relative size as to whether it was best to convert the direct into an indirect or *vice versa*. Doctor Downes stated that he had formerly advised dividing the artery in this type of hernia, but was now of the opinion that the sac could be removed in most instances just as thoroughly without sacrificing this vessel. After the sac had been disposed of the rent in the transversalis fascia should be closed, if possible, using a continuous suture of chromic gut for the purpose. A second retractor was now placed low down under the continuation of the internal oblique and transversalis and the sharp margin of the rectus muscle located with the finger. The sheath of the rectus was then opened along its anterior border, and the muscle exposed from about the level of the internal ring down to its pubic attachment. Three or four sutures of kangaroo tendon were introduced between the outer portion of the rectus muscle and the deepest part of Poupart's ligament. If the transversalis fascia had not been closed satisfactorily as a separate layer it should be included with these structures. The sutures should be placed from one-half to three-quarters of an inch apart from below up—the lowest one passing from just above the insertion of the rectus muscle to the terminal portion of the ligament. After being properly placed, gentle traction should be made on the sutures, drawing muscle and ligament well together, and while thus held they should be tied in the order of their insertion. The usual Bassini operation was now performed from above downward, the sutures picking up a small bit of the rectus muscle and catching Poupart's ligament just superficial to and between those of the first row. Excessive fat should be removed from the cord, but the veins should not be excised. By making use of the rectus muscle an additional layer was added to the weakened posterior wall of the canal. It was not claimed that the fibres of this muscle formed a true union

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with Poupart's ligament or that they always remained permanently in the new position, but they did aid greatly in the formation of new connective tissue at the point where every bit of additional support was of value in the prevention of recurrence. By the use of this method recurrences in their hands had been reduced one-half. However, they felt that there was still room for improvement, and with this in view Dr. R. W. Bolling and the speaker had recently decided to combine transplantation of the rectus muscle with the Andrews operation instead of the Bassini. The mattress sutures were placed as recommended by Andrews for his posterior operation, with the addition of a continuous suture between the margin of the external oblique flap and Poupart's ligament. The lower flap of the external oblique was then sutured over the cord in the usual way. If there seemed to be tension in the upper flap of the external oblique a free liberating incision might be made through the sheath of the rectus well back over the belly of the muscle and parallel with its fibres. It might be stated that sutures placed under tension were of little or no value, as they soon came out. Kangaroo tendon or chromic catgut was used for all deep sutures up to the time of changing methods, but they were now trying celluloid linen in one series and absorbable sutures in another.

DR. A. V. MOSCHCOWITZ said he fully agreed with those gentlemen who believed that an important element in a hernia operation was the union of the aponeurosis to Poupart's ligament, and not the union of the muscle to Poupart's ligament. He believed that that had been proved over and over again, and he had done a number of operations without attaching the internal oblique and transversalis muscles to Poupart's ligament. In Doctor Hoguet's operation, while it was true that the stitch was carried through the external oblique, the illustration did not show the attachment of this structure to Poupart's ligament. Doctor Moschcowitz thought that therein lies the weakness of the operation.

Of course it was well known that it was much more difficult to cure direct than indirect hernia. The difficulty of curing direct hernia was recognized in the army; for the existence and recognition of a direct hernia was considered sufficient reason for discharge. On the other hand, cases of indirect hernia were operated upon in large numbers. Doctor Moschcowitz said he had made it a rule in all his operations for direct hernia to dissect the sac up at least to the obliterated hypogastric artery. If one analyzed the underlying causes of recurrence they would be found to be various. One was that an insufficient part of the sac had been removed, or that a small sac had been overlooked. In discussing this subject some time ago he had been asked the cause of recurrences, and he wished to repeat the statement he then made; namely, that the causes of recurrence were three: (1) When a proper operation was improperly done; (2) if an improper operation was properly done, and (3) the most frequent cause, when an improper operation was improperly done. Success de-

pending on but one contingency, namely, a proper operation properly done.

DR. FRANZ TOREK said that Doctor Hoguet had described an interesting observation, that the peritoneum of a direct hernia could be drawn up into a coexisting indirect hernia by drawing the sac of the latter outward and upward. They had probably all made that observation, but they should be thankful to Doctor Hoguet for bringing it out as a special point. In operating for combined direct and indirect hernia, he had frequently noted that after the indirect sac had been properly mobilized and pulled out the bulging of the direct hernia disappeared, and that no treatment of the direct sac was necessary.

The method of closure of the abdominal wall, as Doctor Hoguet mentioned, differed according to the development of the internal oblique and transversus muscles. When these were strong their attachment to Poupart's ligament would suffice. If they were weak and short the attachment of the rectus to Poupart's ligament was necessary. Doctor Torek said this was brought out in an article he had read before the Society last year, in which he had also called attention to the fact that in direct hernia one must always look out for the bladder, and that it was necessary to lay bare the wound right down to the pubis and to close it down to the pubis. In fact, he agreed with Doctor Hoguet in everything except, perhaps, one point, *viz.*, the slight objection the reader expressed to attaching the rectus to Poupart's, as compared with his recommendation of attaching the reduplicated external oblique to Poupart's. As to the former he mentioned that the muscle was drawn out of place and will tend, by contraction, to be drawn away from its new attachments. If this was true it would be just as much true as an objection to attaching the reduplicated external oblique, because that aponeurosis, inasmuch as it forms part of the rectus sheath, naturally followed the motion of the rectus on contraction of that muscle. Therefore, if the rectus tended to be drawn away from Poupart's, the aponeurosis would likewise tend to be drawn away, especially if there was a reduplication which made the tension greater than it was before. However, the proof of the pudding was the eating, and thus far he had yet to learn of an operation that equalled his own in its results.

DR. WILLIAM C. LUSK said an important consideration in direct inguinal hernia was what to do when the conjoined tendon was deficient. Applicable to repair in the presence of this condition was the use of the Halsted triangular flap from the anterior layer of the rectus sheath. He had illustrated this flap in connection with transplantation of the rectus muscle (ANNALS OF SURGERY, November, 1913, p. 677), and subsequently had observed that a proper cutting of the same would free the restraint exercised upon those of the arched fibres which were inserted into the rectus sheath below the upper limit of the flap, so that they could be brought down and sutured to Poupart's ligament in continuity with the flap. The flap, shaped like a right-angled triangle, was formed by two

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incisions meeting at a right angle, one transverse, about $1\frac{1}{4}$ to $1\frac{3}{4}$ inches above the pubic spine, located just a little above the insertion of the lowermost of the arched fibres directly into the rectus sheath, which should cut the anterior layer of the sheath outward through its outer limit, being careful not to cut through the underlying deep fascia where the layers meet, the other incision vertical, downward to the pubic spine. The carrying of the transverse arm of the incision outward until the last fibre of aponeurotic structure of the anterior layer of the rectus sheath had been severed, was a step which was essential in order to gain relaxation, and the carrying of the vertical arm of the incision downward close against the pubic spine was essential to secure the proper eversion of the flap. He had found that, while there was no slack in the anterior layer of the rectus sheath, there was considerable slack in the posterior layer, and the carving of this triangular opening in the unyielding anterior layer of the sheath gave full play to the slack in the portion of the posterior layer of the sheath behind it, so that the fibres of the internal oblique and transversalis muscles in continuity with the latter portion of the sheath, were thereby released from their tension. Thus the everted triangular flap united to Poupart's ligament and arched fibres attached to the base of the flap, now mobilized, brought down to Poupart's ligament, reconstructed the posterior wall of the inguinal canal. Why not utilize more generally this expedient of Halsted in reconstructing the deep layer of the abdominal wall in the repair of direct inguinal hernia?

DR. H. H. M. LYLE called the Society's attention to the value of position in the treatment of inguinal hernia. Recently much has been said about the value of the physiological balance of muscles in the treatment of fractures. The same principles can also be applied in the operative treatment of inguinal hernia.

The fibres of the internal oblique and transversalis that united to form the conjoint tendon arose respectively from the outer half and outer third of Poupart's ligament. Now, if Poupart's ligament was relaxed by flexion and inversion of the limb the conjoint tendon was automatically relaxed; this relaxation of the conjoint tendon in turn relaxed the related fibres of the rectus. The rectus, the external, internal, and transversalis could be further relaxed by raising the shoulder. For a long time Doctor Lyle has been taking accurate caliper measurements of the distances between Poupart's ligament and the conjoint tendon. A comparison of this distance in the extended and the relaxed position shows that it could be reduced from 20 per cent. to 70 per cent., the average being 35 per cent.

In order to insure firm union all tension must be avoided. Tight suturing means tissue tension, impairment of nutrition, and the possibility of tissue fibrosis. In the operative treatment of inguinal hernia this elementary procedure of placing the parts in a position of muscular rest simplifies the closure, aids union, and assures a comfortable convalescence. In difficult herniæ done under local anæsthesia it is almost indispensable.

Since adopting it as a routine method Doctor Lyle had done fewer and fewer rectus transplantations. It is essential that the position be maintained for at least seven to ten days after the operation.

DOCTOR WOOLSEY said he had employed for over twenty years an operation a great deal like Doctor Stetten's, except that he did not split the outer layer of the external oblique. When the lower flap of the external oblique was brought up, overlapping the upper flap, the cord was turned upward so that it passed with a certain obliquity through the abdominal wall, just as it did in the normal inguinal canal. One could not cure a hernia, direct or indirect, unless the posterior wall of the inguinal canal was made strong. Therefore, he used all layers in fortifying this point and transplanted the cord. Doctor Woolsey said he did not see any need of putting the external oblique in front of the cord. The only trouble that could happen with the cord transplanted beneath the fatty layer was that if there was a recurrence and the man who operated did not know that the cord was left in this position he might cut it by a careless incision. If one sutured the fatty layer separately so the cord would not become adherent in the cutaneous scar, there would not be the difficulty that the cord would become so adherent that it could not be dissected out, as mentioned in the discussion.

Another point that might be mentioned was that of the suture lines for the muscle and upper layer of the aponeurosis. There was not much use in putting in a separate suture line in the muscle, for this could bear little strain without fraying out in the line with the fibres. If the muscle and aponeurosis were sutured together the latter would take the strain off of the muscle.

DR. WILLIAM B. COLEY said that excellent results were apparently obtained from each of the three methods described, and it perhaps required fine judgment to choose which operation was the best. He believed that Doctor Hoguet's operation had some advantages over the others, and that in certain cases the others, doubtless, had some advantages over Doctor Hoguet's. Doctor Coley stated that, for the past thirty years, since 1890, in all operations for inguinal hernia he had placed the lowermost suture through the reflected double layer of the aponeurosis external oblique. In Doctor Hoguet's operation he had used the same suture not only for the lowermost suture, but for all of the sutures, 3 to 4 below the cord. The greatest difficulty in obtaining a cure in direct hernia consisted in completely and firmly closing the lower portion of the inguinal canal. In certain cases the tension might be too great to permit bringing the reflected portion of the aponeurosis in apposition with Poupart's ligament all the way to the cord, according to Doctor Hoguet's method. In such cases it might be better to use the technic just described by Doctor Downes for bringing the rectus muscle in apposition with Poupart's ligament. In certain cases Doctor Coley believed it was a distinct advantage to employ the Andrews overlapping method as described by Doctor

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Downes. Doctor Coley expressed the opinion that it was a great disadvantage to bring the cord out superficial to the aponeurosis and covered only by the skin, either by the method just described by one of the speakers or by the typical Halsted method. The disadvantages of the Halsted method had been the recurrences at the site where the cord came through the opening in the aponeurosis. Anyone who had been obliged to operate for a recurrence following the Halsted method must have recognized the great difficulty in separating the cord from the firm adhesions to the overlying and underlying structures. Doctor Coley believed it was far better that the cord should be covered with the aponeurosis as in the typical Bassini operation or in the overlapping Andrews method. He thought it would require at least two years before we could pass final judgment as to the value of any technic in the operation for the radical cure of hernia. It should be remembered, however, that the great majority of recurrences in hernia took place within the first year; that the direct recurrences were earlier than the indirect; that about 80 to 90 per cent. of the recurrences in direct hernia occurred in the first year (the majority of these in the first six months), so that if a patient remained free from recurrence in direct hernia for the first six months, the probability was that he would remain cured.

DR. A. V. MOSCHCOWITZ said he thought Doctor Coley's statement that the internal oblique muscle united to Poupart's ligament was rather important; there was no doubt of that, but it was also certain that the union between two homogeneous structures like the external oblique and Poupart's ligament was much stronger and safer. He would take this occasion to repeat a story he had told before. A number of years ago a member of his family was operated on for a hernia by a most prominent surgeon. Bassini's operation was done absolutely *secundum artem*. Within six weeks there was a recurrence. At the second operation, with the exception of the cutaneous cicatrix, it was difficult to tell that any operation had been performed. The internal oblique and the transversalis were back in their old position. Doctor Moschcowitz said he was convinced that this case alone proved the flimsiness of the union between heterogeneous structures.

DOCTOR DOWNES said in regard to recurrences he did not wish anyone to get the impression that he had no recurrences. He thought he had about 6 per cent. recurrences in cases that went over one year. He cited the case of one man upon whom he had operated for hernia and who later came to him for some other trouble. In examining him he found that he had a slight recurrence of the hernia of which he was not conscious. Cases of this kind impressed him with the fact that statistics based on correspondence with the patient in regard to recurrence were not reliable, as patients frequently had a slight bulging or recurrence and did not know it. He thought recurrences were nearer 10 per cent. rather than 2 or 5 per cent. in the cases he had had in his own personal experience.

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DOCTOR HOGUET, in closing the discussion, said there were several points he wished to make clear. First, on account of the anatomical peculiarities, the more direct hernias he did the less inclined he felt to follow any set operation. He was convinced that one often found large-sized direct hernias which could be cured by the Bassini where the bulk of the internal oblique and transversalis muscle was large enough and where the rectus was narrow. There were a number of cases that could be cured by the rectus transplantation. If there was not enough conjoined tendon to suture down and the rectus narrow and tight, and if the aponeurosis was strong and firm and loose enough, it could be brought down and sutured to Poupart's ligament.

Doctor Hoguet said he wanted to correct Doctor Moschcowitz's impression. If there was any question as to whether muscle united to fascia, then this ought to be an ideal operation, for muscle was not only sutured to fascia but also aponeurosis to fascia. As one sutured one found the reflected edge of the external oblique came absolutely down to and hugged Poupart's ligament. As to the conjoined tendon he imagined it was pushed to the back and down and Poupart's ligament united to the posterior surface of the fascia lata as it came down to Poupart's ligament.

As to the objection that Doctor Torek made that it pulled the aponeurosis of the external oblique out of line, Doctor Hoguet said he would not use the operation where the aponeurosis was not loose. In many large hernias he had found the aponeurosis of the external oblique such that it could be pulled down to Poupart's ligament without any tension whatsoever.

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